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DEPARTMENT OF THE INTERIOR
Albert B. Fall, Secretary

UNITED STATES GEOLOGICAL SURVEY
George Otis Smith, Director

MINERAL RESOURCES
OF THE
UNITED STATES

1918

G. F. LOUGHLIN
Geologist in Charge, Division of Mineral Resources

Part I—METALS

G. F. LOUGHLIN, Geologist in Charge

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MINERAL RESOURCES OF THE UNITED STATES, 1918—PART I.

THE WORK ON MINERAL RESOURCES DONE BY THE UNITED STATES GEOLOGICAL SURVEY.

By Edson S. Bastin and H. D. McCaskey.

The United States Geological Survey has been charged by Congress with many duties, but one of the most important is that of making an inventory of the country's mineral wealth as utilized in the mineral industries. Considered in connection with this duty, the Survey may be described as an accountant whose task it is to know where the valuable mineral deposits of the United States are situated; what, if anything, they are contributing year by year or month by month to the economic life of the country; and, in a general way, what they may be counted upon to contribute in future years.

The mineral investigations of the Geological Survey fall naturally into three major groups. Those of one group, conducted by the division of geology, consist of the study, interpretation, and mapping of the geology of particular districts, of the discovery of mineral deposits, of the determination of their approximate magnitude and their suitability for industrial uses, and of the study of the natural conditions or processes that control their formation or that limit their development or extent. The mineral investigations of a second group, conducted by the division of mineral resources, consist in compiling a continuing statistical record of the mineral production of the country and in reporting new sources of minerals or new methods of their utilization. Within recent years a third group of the mineral investigations of the Geological Survey has consisted in the classification of the public lands with respect to their content of mineral wealth. This work finds immediate application in controlling the conditions under which such lands may be sold, leased, or utilized, but it has increased the knowledge of the country's mineral reserves, especially of those that are little developed or not developed at all.

The year 1918 was the thirty-seventh year of consecutive compilation of mineral statistics by the United States Geological Survey, and many of those who have contributed to the success of this work or have been benefited by it may welcome the following brief story of its development and its scope.

The first annual report of the United States Geological Survey on the country's mineral resources was that for the year 1882. It was specifically authorized by an act passed at the first session of the Forty-seventh Congress, and it was compiled under instructions issued August 5, 1882, by Maj. J. W. Powell, who had succeeded Clarence King as Director of the Geological Survey. Since then a systematic annual canvass of the mines, quarries, and oil and gas wells of the country has been made by a regularly organized division of the Survey, for many years known as the "division of mining statistics and technology," later as the "division of mining and mineral resources," and in more recent years as the "division of mineral resources." The first geologist in charge of the division was Albert Williams, jr., and he had among his associates Charles G. Yale, in charge of the Pacific division and then editor of the Mining and Scientific Press, of San Francisco. Mr. Yale is still in charge of the San Francisco office of the Survey and probably is acquainted with more mining men on the Pacific coast than any other man. Among other associates was David T. Day, who succeeded Mr. Williams in charge of the work in 1886 and remained as geologist in charge until 1907, when he was succeeded by one of the division staff, Edward W. Parker, who remained statistician in charge until his resignation from the survey in 1915. Mr. Parker was in turn succeeded by his principal associate, H. D. McCaskey, who relieved him early in 1915 and continued as geologist in charge of the division until January 3, 1919, when he was relieved by Edson S. Bastin, the present geologist in charge. During the 37 years covered by this work, from late in 1882 to the end of 1919, the Survey has had only three directors—J. W. Powell, Charles D. Walcott, and George Otis Smith; and the division has had only five chiefs—Williams, Day, Parker, McCaskey, and Bastin. This long-continued service has made for continuity of effort and for the maintenance of worthy tradition and of esprit de corps, and as each administrative chief has been succeeded by a former associate the whole work has been marked by continuous and consistent growth.

It is interesting to recall, however, that the "organic act" of the Survey—the act upon which the organization of the Geological Survey was laid out by the first Director, Clarence King, in 1880—provided for investigations of the country's mineral resources, and in the census for that year well-known geologists of the Survey—S. F. Emmons, George F. Becker, Raphael Pumpelly, and others—assisted Mr. King in the first systematic statistical investigation of the mineral production of the United States. These men, with Henry Gannett and Whitman Cross, also of the early Survey staff, assisted in compiling the first report of the series now entitled "Mineral Resources of the United States."

The Geological Survey has directly and notably aided in the statistical canvass of mines and quarries in the four censuses taken since its organization—those for 1880, 1890, 1900, and 1910—and is now preparing to cooperate in the census for 1920. In the mineral census for 1880, conducted by the Survey at the request of the Census Bureau, the method of obtaining returns directly from producers was first put into practice in a broad way. Cordial and effective relations with the entire mineral industry were then established by the Survey and have since been continued and widened.

After the statistical work was begun by Mr. Williams and during much of Dr. Day's administration a central staff in the Survey maintained current lists of mineral producers, sent out schedules, and compiled and tabulated the returns received, but many of the chapters were written on a contract or for an honorarium by specialists not on the permanent staff of the Survey and not residing in Washington, who gave only a part of their time to the work. In this way the Survey availed itself of the experience and knowledge of experts like John Birkinbine, as to iron; Charles Kirchoff, as to copper, lead and zinc; and George F. Kunz, as to gems and precious stones. During the early part of this period, also, when the Survey's central force was small and when it was employing specialists who were engaged principally in other occupations and were not in constant touch with the statistical work, it was not always practicable to make the canvasses as complete as they were made in the first year (1880) and as they were again made in later years; but though some loss was thus suffered, some gain was made by earlier publication of results.

To keep more closely in touch with the rapidly developing mineral industries and to cover every phase of economic and mining geology it was finally determined to revert to the plan of making a comprehensive and detailed statistical campaign in every mineral industry, similar to that made by the Survey for the census of 1880 but on a much larger scale. It was arranged to develop specialists from the economic geologists and trained engineers and statisticians of the permanent staff of the Survey and to reestablish permanent western offices. Waldemar Lindgren undertook the reorganization of the work on the metals and really became successor to Clarence King in directing the investigation, both geologic and statistical, of the precious metals, of copper, lead, and zinc, and of the rare metals. He organized the Survey's offices in Denver, Salt Lake City, and San Francisco and brought them into close contact with the metal-mining industries, except the iron industry. About this time Mr. Parker succeeded Dr. Day in charge of the mineral statistical work. With the appointment of selected specialists from the Survey staff for every commodity and with several accessions to the trained statistical and clerical staff, the statistical work was made more complete and accurate and was supplemented by field work done by trained economic geologists. Thus we find the organization to-day, with some changes in personnel, bringing to its task the strength gained by the continued development of methods and of men and by intimate professional contact with the mining industry during a period of nearly 40 years.

From 1880 to the end of 1918 the value of the mineral production of the United States has increased from $367,000,000 to more than $5,500,000,000, nearly 15 times, or, measured in another way, from a little over $7 per capita to more than $52. The funds allotted for measuring this production have increased from $10,000 in 1890 to $100,000 in the year 1918–19, or only 10 times. The staff in 1918 numbered 32 technically trained specialists, most of them geologists and mining engineers, of whom 12 devoted their entire time to the mineral statistical work and the remainder devoted some of their time to geologic studies. In addition, 43 stenographers and clerks, many of them highly trained in statistical work, were employed for full time.

As the statistical work has grown in magnitude it has tended to absorb a larger and larger share of the time of specialists who were expected to devote only part of their time to it. Many geologists who have enjoyed the "touch with the practical" which the work on mineral resources affords have found themselves forced by the growth of the mineral industries to devote their full time to the work and to abandon their chosen scientific labors. This condition has greatly retarded the geologic work of these members of the Survey, who have been unable to finish extensive and important field investigations. Recently a remedy for this condition has been sought in the selection for work on mineral resources of persons willing to devote their entire time to it, and the new grade of "mineral geographer," established early in 1919, is designed to furnish, through the civil-service system, eligibles for this work.

The field covered by the intimately interlocking activities of the Geological Survey in the investigation of the mineral resources of the United States now includes every known raw mineral product and commodity of economic value and anticipates future development by including some rocks and minerals that are of no present economic value but that may be valuable in the future. The Survey's lists of mineral operators now contain more than 110,000 names and addresses, including operators of mines, quarries, wells, mills, smelters, and refineries, all of whom are in direct touch with the Survey, not only supplying information, but also receiving it. The work has received international recognition as the most complete governmental investigation of mineral industries yet made, and Congress has repeatedly given it approval and the substantial recognition of increased, though still inadequate, funds and facilities.

In all its investigations of mineral resources the Survey has aimed to avoid duplication of work by cooperating as closely as practicable with other Federal bureaus and offices, particularly with those that are doing statistical work or that are especially interested in mineral statistics, such as the bureaus of Mines, Standards, and Foreign and Domestic Commerce and the Mint. Many trade bodies and 18 State organizations also cooperate with the Survey in work on mineral statistics, and cooperation will be extended to other States as rapidly as they make funds or facilities available for their share of the work. The Geological Survey recognizes, too, that a statistical service organized for the benefit of the mineral industries should impose no unnecessary burdens upon those industries and has therefore avoided the unnecessary multiplication of requests for the same data.

At the beginning of the war in Europe in 1914 the Survey, as it had compiled a mass of data on domestic mineral resources and some on foreign resources, and was in intimate contact with all branches of the mineral industries, was able to furnish the public with much information relating to the raw materials needed to fill war orders from Europe. The rapid increase in the number of inquiries made during the war showed the usefulness of the work performed. Little has been published concerning the great and highly diversified war work of the Geological Survey, which extended through many mineral industries and through all the Federal departments, for it has been held throughout the Survey that this work was a privilege not to be cheapened for self-glorification or loudly exploited as an exhibition of patriotism. Now that the war is over, the Survey's work in it may be more freely mentioned, and, in justice to the men who aided in it, an account of it should form a part of every complete record of the participation of the United States in the war.

When the United States entered the war the Survey was immediately called upon to assist the War and Navy departments and many new war boards, especially the Council of National Defense, the War Industries Board, the War Trade Board, the Shipping Board, and the Capital Issues Committee, in their rapidly expanding war activities. With no increase in appropriation and, for most subjects or materials, no increase in technical or clerical staff, the statistics of several mineral resources were collected not annually, as before, but quarterly, monthly, or even weekly. This expansion was made possible only through the complete sacrifice of all the purely scientific work that had before occupied a part of the time of most of the mineral-resources specialists and through longer hours of more strenuous labor by the specialists and clerks.

The Survey furnished rooms and other facilities for mineral committees of the War Industries, War Trade, and Shipping boards and for the interdepartmental Joint Information Board on Minerals and Derivatives, adjacent to its own specialists and records, and thus and in other ways aided the numerous war organizations in finding their way to effective work. By establishing this intimate contact with the organizations that needed information concerning minerals, comparable to its intimate contact for many years with the industries that supply the information, the Survey had a unique opportunity to be of larger use—an opportunity of which it gladly availed itself to the limit of its ability.

The experience gained by the Survey during the war and the growth of the demand for mineral statistics have shown the need of expanding this work so that it may include the preparation of more detailed and frequent current domestic statistics and more exhaustive research into foreign mineral resources. To adapt the organization to its changing responsibilities the Director of the Survey provided for a larger service, effective at the beginning of 1919. The most noteworthy part of this provision, perhaps, has been the establishment within the division of mineral resources of a section of foreign mineral deposits, charged with the assembling, mainly from the official reports of foreign Governments, of statistics of mineral production, imports, and exports and with the compilation, from both public and private sources, of information showing the location and size of foreign mineral deposits, particularly those that contribute to our own mineral imports or that compete with our mineral exports. The interest and cooperation of some large American companies that are interested in foreign mineral deposits have already been enlisted in this great work, but as only a small fund and personnel are available for its prosecution it has merely been begun. In the work on both foreign and domestic mineral resources the Geological Survey needs the continued and increased support of the public and of Congress that it may go forward confidently to larger and more effective service.

MINERAL RESOURCES OF THE UNITED STATES.

INTRODUCTION.

By Edson S. Bastin,

Geologist in Charge, Division of Mineral Resources.

SCOPE OF REPORT ON MINERAL RESOURCES.

The two parts of the report Mineral Resources of the United States (Part I, Metals, and Part II, Nonmetals), of which this chapter forms the introduction and summary, constitute the final official record of the mineral production of the United States for the year 1918. They contain the statistics of production in the United States, the imports and exports for that year and for several preceding years, and the records of important new developments during 1918. The reader in search of full information in regard to a particular mineral industry is advised to consult also the volumes of Mineral Resources for previous years, in which many details not repeated in later reports will be found. For statistics carried forward, however, the reader should consult the latest volume, as it contains any revision made, not only of the reports for the years preceding but also of the reports published separately in advance of the volume. Each volume is a supplement to all that have preceded. Special features of an industry are discussed more fully in some years than in others, and chapters issued during the last decade and containing particularly full reviews are listed in the introduction to the volume for 1917.

For a brief historical review of the development of the mineral industries of the United States from 1880 to 1916, inclusive, the reader is referred to the introduction to Mineral Resources for 1916. For a statistical summary of mineral production going back to 1880 the reader is referred to the summary chapter, by Miss Martha B. Clark, in the volume of Mineral Resources for 1915, and to the table in this summary, page 26A.

VALUE ASSIGNED TO OUTPUT.

The value of the contribution of our metallic output to our industrial needs is best shown by determining the value of the refined or partly refined metal—the marketable product. This value is, of course, ordinarily greater than the value of the ores from which the products are obtained, and the movement of bullion, matte, and refined metal does not at all indicate the volume of ore transported by the railroads and other carriers or the demands made on the transportation lines by the mineral industry as compared with the agricultural and other industries. The compilation of the statistics of the production of pig iron has generally been supplemented by an accurate determination of the quantity and value of the iron ore produced, but the quantity and value of pig iron have been retained as units for the iron industry. Many of the ores of the precious and semiprecious metals are complex associations of several metals and gangues, and the same ore may have different values, or none, its value depending on the metallurgic and other treatment it may require. The quantities and values of such ores are therefore best measured by the metal actually extracted from them and made marketable. Chromic iron ore, manganese ore, manganiferous ore, and bauxite, on the other hand, are marketed as such. The quantities and the values of the nonmetals are likewise placed upon the products in the condition in which they are first sold. The quantities and values of the fuels, phosphate rock, and some other nonmetals therefore represent raw or only very slightly dressed products, in the condition in which they first become articles of trade. Salt appears as the content of brine, in various refined conditions, or as rock salt. Gypsum is sold as crude, as ground, or as calcined. Cement, however, is the commercial product reported, rather than the raw material from which it is made. The clay products, except very small quantities of special clays that are sold raw, first appear in statistics as brick, terra cotta, tile, porcelain, pottery, etc. As quarry products are sold in three forms—rough, partly dressed, or finished—there is no way of determining their quantities and values except by considering them in the condition in which they are first marketed.

ACKNOWLEDGMENTS.

The United States Geological Survey is in touch, by correspondence, conferences, and field work, with practically all branches of the mineral industry, and it is therefore impossible to make more than general acknowledgment for the vast amount of data contributed by those engaged in that industry. Opportunity is taken here, however, to make this general acknowledgment and to express grateful appreciation of the trouble and personal interest taken by correspondents to make the reports of real value. The total number of these correspondents was well over 100,000 in 1918. Survey geologists in 1918 continued to make special field investigations of mineral resources urgently needed for war industries and received many courtesies and much aid in this work.

ORGANIZATION.

The division of mineral resources of the United States Geological Survey, which is responsible for the annual reports "Mineral Resources of the United States" and related work, was divided during 1918, as in previous years, into two sections—the metals section, which prepares the reports of Part I, and the nonmetals section, which prepares those of Part II, including fuels, structural materials other than metals, chemical materials, mineral fertilizers, and other nonmetallic products. H. D. McCaskey, in charge of the division of mineral resources, also had personal charge of the metals section, and G. F. Loughlin was the geologist in charge of the nonmetals section. Mr. McCaskey also had supervision of the western offices of the division and of cooperative relations with the State geologists.

Shortly after the signing of the armistice Mr. McCaskey, because of ill health, which was aggravated by the strain placed upon him during the war, asked to be relieved of his duties and was succeeded by the writer. The Geological Survey, and particularly the division of mineral resources, takes this opportunity to express its appreciation of Mr. McCaskey's years of service, first as specialist on gold, silver, and quicksilver, later as chief of the metals section, and finally as chief of the division.

During 1919, when the tables for this volume were compiled, the division was divided into four sections—metals, G. F. Loughlin, geologist in charge; nonmetals, except fuels, R. W. Stone, geologist in charge; mineral fuels, C. E. Lesher, geologist in charge; and foreign mineral reserves, J. B. Umpleby, geologist in charge. The writer, as geologist in charge of the division, supervised the western offices and the cooperative relations with State geological surveys.

The western offices were established primarily for the collection and compilation of data for the annual mines reports on the precious and base metals of the Western States, but they have been brought so closely in touch with the mineral industries from the Rocky Mountains to the Pacific coast generally that they now cooperate with the Washington office on many branches of the mineral-resources work and serve the mining industries and the public at large throughout the West as general bureaus of information and of distribution of Survey publications. The statisticians in charge of the western offices were the same as in preceding years: Charles W. Henderson, 409 New Post Office Building, Denver, Colo.; Victor C. Heikes, 312 Post Office Building, Salt Lake City, Utah; and Charles G. Yale, 305 Customhouse, San Francisco, Calif. Mr. Henderson is author of the mines reports for Colorado, South Dakota, Wyoming, New Mexico, and Texas; Mr. Heikes (assisted by C. N. Gerry) is responsible for the mines reports for Utah, Nevada, Arizona, Montana, Idaho, and Washington; and Mr. Yale contributes the mines reports for California and Oregon, and is coauthor also of the report on magnesite for the entire country.

The close cooperation of the division of mineral resources with other divisions of the geologic branch continued and most of the reports on mineral resources were written, as in recent years, by geologists working in more than one division, who specialize on the subjects treated by them. The advantage of this arrangement is to utilize the full resources of the Survey in the service of specialists familiar with the occurrence, treatment, and use of the mineral substances covered.

This group of specialists includes many of the ablest economic geologists, chemists, and engineers of the Survey, and the contributions they make are of special value because of their training in field and office, which especially fits them for the well-rounded study of their respective subjects. Many of the clerical staff have now been connected so long and in so responsible a way with the collection and tabulation of statistics assigned to them that they are most creditably identified with their subjects. Their intelligent scrutiny and criticism of the returns and their skillful interpretation of the results are invaluable in saving the time of the specialists, and their conscientious devotion to duty has maintained the high standards set for accuracy and completeness of the reports.

The activities of the new section of foreign mineral reserves are not reflected in this volume, with a few exceptions such as the table showing the world's production of copper by H. A. C. Jenison and the notes on foreign chromite deposits by E. F. Bliss and H. R. Aldrich. This section was principally engaged during 1918 in preparing atlases of world's production and reserves of all mineral commodities of international interest and in gathering and indexing information on foreign mineral deposits.

COOPERATION WITH STATE GEOLOGICAL SURVEYS.

In the collection of data for reports on mineral resources the United States Geological Survey has had since 1910 the cooperation of many of the corresponding State organizations. The statistics obtained by pooling efforts and field and office facilities are jointly checked and are the official figures of both State and Federal surveys. The objects aimed at in cooperation are mainly the avoidance of duplication of effort on the part of both compilers and operators, and also of divergent sets of figures bearing the official stamp.

Cordial acknowledgment for helpful and most satisfactory cooperation is made to the State officials for the statistical campaign for 1918.

SALIENT FEATURES.

The statistics of mineral production in the United States for 1918 show that in the last 10 months before the armistice the mineral industries of the country had become remarkably well adjusted to the extraordinary economic demands of war. Production increased in nearly all the minerals that were directly or indirectly essential to the war, such as mineral fuels, the major base metals, except zinc, and many of the minor base metals, particularly those which are normally imported from distant parts of the world but for which shipping could no longer be spared.

The coinage metals declined greatly in output. Gold was bound legally to a fixed price, while costs of production were soaring; the production of silver was hampered by a great increase in the imports of bullion, chiefly from Mexico, and by other causes. The most notable decrease was in building materials, the output of which declined 20 to 60 per cent, labor and capital being withdrawn from these industries and focused upon those that were more essential in the war economy.

The approximate total value of the mineral production of the United States in 1918 was $5,540,496,000, an amount more than half a billion dollars in excess of that for 1917, two billions in excess of that for 1916, and more than double that for any previous year. The increase as compared with 1917 was due to the advance in prices, whereas in total quantity of mineral products 1918 fell short of 1917.

The following brief review outlines some of the salient features of the mineral industry during 1918. Primary consideration is given to such commodities as coal, petroleum, iron, copper, and gold, which constitute the adult and main supporting members of the mineral family, and secondary consideration to the "war babies" in the family, which, like most other babies, have received perhaps an undue share of public attention.

Mineral fuels, which are fundamental to all industrial life, merit first attention. Exports of coal to Europe during the war formed only a negligible percentage of the domestic production and were not greater than in previous years. France and Great Britain, with coal fields of their own, were less in need of our coal than of the many things made by coal-driven machinery. For petroleum and its products, however, in marked contrast to coal, we were the Allies' chief source of supply.

The year 1918 was in general a prosperous one in the coal industry. The tremendous increase in demand which began in the last quarter of 1916 continued through 1918 until the signing of the armistice in November and brought increased production to the point where the limit of the railroad capacity was reached, with the demands still unsatisfied. Prices would have been very high, possibly exceeding the unheard-of prices in the first half of 1917, had they not been under Government control after June of that year. Although the prices fixed by the Government were substantially below the high prices of the winters of 1916 and 1917, those finally arrived at in the last half of 1918 were substantially above the average price realized on all coal produced in 1916 and 1917.

The unprecedented demand by both Army and Navy for fuel oil and gasoline led to the marketing of more petroleum than in any previous year, but the percentage of increase was the smallest since 1915 and drafts upon pipe-line stocks were the largest yet recorded. The relatively slight increase in the face of the urgent demands serves notice of the early approach of the period when the curve of the production of American wells will be downward rather than upward and emphasizes the necessity for the acquisition by Americans of additional foreign sources of supply if the needs of the United States as the world's greatest consumer of petroleum are to be met. The increased demand was followed by advanced prices for crude oil, which were stabilized, with Government approval, at record levels during the closing months of the year.

The war demands for iron and steel were as insistent in 1918 as in 1917, but shortage of labor, the necessity of employing many inexperienced miners, and difficulties of transportation, particularly in the early months of the year, resulted in a decrease of over 7 per cent in the production of iron ore, the requirements being met by drawing upon stocks. The production of pig iron was slightly greater than in 1917 but fell short of the record production of 1916. The production of steel in 1918 shows a slight decrease as compared with 1917. Prices throughout the year were stationary, as a result of Government regulation.

Copper and zinc as components of brass are hardly less important than steel in the manufacture of many war materials. The smelter production of copper from domestic ores and the refinery production from both foreign and domestic ores, increased slightly as compared with 1917, but the year on the whole was not so prosperous in the copper industry as 1916 or 1917 because of decline in prices and increase in costs. During the later part of 1917 and the early part of 1918 difficulties in transportation seriously interfered with the transfer of blister copper from the smelters to the refineries, with the result that large stocks of blister copper accumulated at the smelters and in transit, while the refineries were operating far below their capacity. After the transportation situation had improved labor troubles at the refineries still inhibited capacity production, which was not attained at any time during the year. Stocks of refined copper, in general, decreased gradually until September, when an increase began which was gradual at first but rapid after the signing of the armistice, and at the end of 1918 stocks were 66,000,000 pounds in excess of those at the beginning of the year. By special agreement between the copper producers and the War Industries Board after the armistice was signed, the output of copper ores was maintained at a high level until the end of the year. The price of 23½ cents a pound for refined copper, fixed early in September, 1917, continued until July, 1918; it was then increased to 26 cents and continued at this figure until the end of the year, when all control of prices became inoperative. After the armistice was declared there was almost a complete cessation of sales for the remainder of the year. Late in the year steps were taken toward the formation of a Copper Exporters' Association for the purpose of lessening competition and stabilizing prices in the export trade.

As a result of the overproduction of zinc in 1916 and 1917, under the stimulus afforded by large demand and high prices, and of the decrease in the use of zinc for galvanizing, the year 1918 showed a decline of 16 per cent in production and also lower prices. The high price of zinc early in the war greatly curtailed its use for galvanizing, and later, when zinc again became cheap, the output of sheet iron and steel had all been allocated for Government purposes, so that the galvanizing industry was practically destroyed for the time being and the production of zinc became mainly dependent on war demands. The prices of zinc in general declined during the first third of the year, rallied during the second third, and again declined during the last third, the demand in November being so slack that the signing of the armistice produced scarcely any effect on the declining price curve. At the end of the year many plants were idle, abandoned, or dismantled; in one State, for example, only 3 plants were in operation out of a total of 18 operated in 1916.

The output of refined lead from domestic ores was slightly less than in 1917 and 1916, but the total output from both foreign and domestic sources was the largest ever recorded, owing mainly to the increased quantity of Mexican bullion available. Early in the year, when congestion of transportation and the difficulty in enlarging plants were curtailing production, serious apprehension was felt as to the ability of the lead industry to meet the war demands; later, about the middle of the year, the Lead Producers' Committee was authorized to allocate the supply of lead to industries in accordance with their war-time importance. The committee likewise limited the price to 8.05 cents a pound, to which it had risen from 6.6 cents at the beginning of the year. Although the lead situation necessitated precautionary measures, there was not at any time a lack of this metal to meet all indispensable demands. With the signing of the armistice the price began to drop rapidly and at the end of the year it had fallen to 5.75 cents a pound. Mining and smelting were both greatly curtailed during the last two months of the year.

Because gold could not share in the increase in price that affected most other commodities, including the supplies and machinery necessary for gold mining, the output of this metal in the United States in 1918 was about $15,000,000 less than in 1917 and was the smallest in 21 years. The serious plight of the gold miners led to demands for Government assistance and to the appointment of committees in two

Government departments to study the problem. Reports were prepared but no remedial action was taken before the armistice removed the necessity for such assistance. Rigid restrictions on the exportation of gold were enforced throughout the year and are still effective, in May, 1919. The recovery of the gold-mining industry seems likely to be slow, as it will follow the gradual decline in the price of labor and supplies.

Silver mining also declined in 1918, the output being 3,930,000 ounces less than in 1917 and the smallest since 1913. The average New York price increased from 82.4 cents in 1917 to 98 cents in 1918, and was controlled during most of 1918 by the Government purchasing price of $1 an ounce. The increase was inadequate to meet the increased costs of mining and smelting, and production therefore declined. Other causes for the decline in production were the great increase in the imports of bullion, chiefly from Mexico, and the marketing by the Government of silver bullion from the melting of silver dollars. In April, 1918, an act was signed authorizing the sale of 350,000,000 silver dollar coins held in the United States Treasury, and during the year approximately 161,000,000 of these coins were sold. The main purpose of this act was to assist Great Britain in quieting unrest in India and in procuring vitally needed war supplies from that country. Most of the silver was sold to Great Britain and expended by her for Indian goods, and these measures were successful in relieving a most serious colonial situation.

The large increase in production of mineral materials needed directly or indirectly in the war was made possible by the diversion of capital and labor from industries that in the stress of war became less essential. Although such readjustments were fostered by governmental agencies, they proceeded for the most part naturally and show the degree to which the energies of the country became focused upon the one great objective of winning the war. The industries contributory to building operations exemplify these readjustments. In 58 of the leading cities of the country the number of buildings erected or authorized decreased more than 20 per cent, as compared with 1917. Among the major mineral materials needed in building operations, lime declined 15 per cent in output, reaching the lowest level for 10 years and decreasing in every important State except Ohio and Tennessee. The output of cement, in spite of the slight increase in price, also declined more than 23 per cent during 1918, reaching the lowest level since 1909. Not a single district recorded an increase. The output of crude gypsum declined 24 per cent, that of crushed stone 27 per cent, and that of building stone 51 per cent. All Government restrictions on building operations were removed soon after the signing of the armistice, but there was no appreciable recovery in these industries before the end of the year.

Of the "war babies," those belonging to the steel-making family were particularly thriving during the year. The output of manganese ore, the principal source of the alloys ferromanganese and spiegeleisen, which are essential in the making of steel, increased during 1918 to a degree never believed possible in this country and more than doubled that for 1917. Chromite, utilized in the chrome steel of armor plate and automobile frames, also exceeded all previous records of production, and the industry attained so great an impetus in the later part of the year that had hostilities continued the total production for the year would probably have been equal to the country's consumption. After the armistice was declared, however, the production of chromite, mainly from California, rapidly declined. The output of tungsten ore, the source of ferrotungsten, the great essential in the manufacture of tool steel, continued to be greatly in excess of that in pre-war times but was somewhat less than in 1916 and 1917, owing to the fact that imports were the largest yet recorded. The end of the year found the country with stocks on hand amounting to about 6,000 tons, a good working reserve had the war continued, but from one to two years' supply under conditions of peace. Graphite, which is used in making crucibles for melting steel, brass, and other metals, attained a record production in 1918, but the output was still insufficient to meet the demand, which was supplied largely by imports and by stocks of foreign graphite held over from 1917. After the signing of the armistice the actual or expected removal of restrictions on importation and the sudden slackening of demand for steel and other metals for war uses produced a collapse in the domestic manganese, chromite, tungsten, and graphite industries. After the large present stocks are depleted the recovery of these industries to a strength greater than before the war may be expected, but the records of war years will not soon be duplicated.

The task of supplying from domestic sources the 240,000 tons of potash (reckoned as K_2O) annually imported from Germany before the war was a hopeless one, and the American agriculturists accepted the alternative of doing without most of this supply. The lack of this material seems, however, to have been so little detrimental in some districts as to lead to the suspicion that the American farmer, perhaps overpersuaded by the propaganda of the German potash syndicate, had acquired the potash "habit." Although inadequate for our normal needs, the production of potash in 1918, amounting to 54,800 tons (K_2O), was a very creditable performance and showed an increase of 68 per cent over the output in 1917. The potash market was very dull during the last two months of 1918, probably owing to anticipation that European potash would soon be available at lower prices.

A small war industry which presents some features of unusual interest is the manufacture of magnesium, the lightest known metal, by electrochemical methods. This industry began in 1915, when imports from Germany were cut off. The production increased rapidly, reaching 284,000 pounds in 1918. The metal was in demand for signaling and illumination on the battlefields and for alloying with aluminum in the frames of airplanes. Although lighter than aluminum the ease with which it oxidizes and ignites prevents the pure metal from being used for many of the purposes to which aluminum is applied. Its future field of usefulness appears to be as a deoxidizer in metallurgy and for alloying with various metals, particularly aluminum, to increase their lightness and strength.

SUMMARY.

By MARTHA B. CLARK.

PLAN OF PUBLICATION.

On August 7, 1919, in issuing the annual summary of mineral production for the first time in preliminary form the United States Geological Survey began a new class of Survey reports which it is thought will be of wide usefulness. It is hoped to issue a similar report each year within six months after the end of the calendar year covered by the canvass and thus to furnish to the public the statistics of mineral production at a much earlier date than was possible under the former plan of publication. This final summary contains all statistics (revised to date) which appeared in the preliminary summary and in addition tables of production by States for which data were not available when the preliminary summary was issued.

SCOPE OF SUMMARY.

Beginning with this issue, the scope of the summary has been materially enlarged by the addition of sections on the various minerals, giving data on domestic and foreign production, supplies, consumption, imports, exports, stocks, and prices, for a series of years, so that the report in its present form is more truly a summary of the various chapters comprising the two parts of Mineral Resources than it has been in any previous year. These sections are arranged in alphabetic order and may be found on pages 31A to 116A.

UNIT OF MEASUREMENT.

The unit of measurement used by the Geological Survey for each mineral product in the reports on the mineral resources is that common to the industry concerned, and the variation in these units makes it impracticable, if not impossible, to combine and compare the different minerals except in their value.

ELIMINATION OF DUPLICATION.

From the totals for the entire United States, shown in the following general tables, duplication has been eliminated wherever practicable. For instance, the value of the coke has been excluded from the totals, as the value of the coal used in its manufacture enters into the statistics of coal production. In mineral paints, the chemically manufactured pigments (white lead, red lead, lithopone, litharge, and orange mineral), whose aggregate value exceeds $20,000,000 annually, are not given in the table, as the base from which they are made is included in the output of lead or zinc, whereas the zinc and lead pigments (zinc white or zinc oxide, zinc-lead, leaded zinc oxide, sublimed blue lead, and sublimed white lead) are included (except in State tables as noted on page 17A), being made in large part directly from the ores and therefore not entering into the lead or zinc totals, which represent smelter output. The value of the pig iron, rather than that of the iron ore, is included (except in State tables as noted on page 17A) in the total, being considered the best means of presenting the statistics of iron in its first marketable condition. Similarly, the value of the products of the clay industries is included as representing the first marketable condition of the greater part of the clay produced. The quantity and value of the clay mined and sold in the raw state by miners to manufacturers of clay are shown separately, but the value is not included in the total.

IMPORTS AND EXPORTS.

All figures of imports and exports in this summary were compiled by J. A. Dorsey, of the Geological Survey, from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce, having been converted by Mr. Dorsey to the various units of measurement used in this report and arranged by him in their present form. The imports cited are those for the calendar year unless otherwise stated. Imports "for consumption" may or may not be identical with "general imports," as merchandise brought into the country late in December, for example, may be entered immediately for consumption, or it may be put into a warehouse and not withdrawn for consumption until the following calendar year. It is then credited "for consumption" to the year of its withdrawal from warehouse. All figures of imports according to the country from which the material is shipped necessarily represent "general imports," as the Bureau of Foreign and Domestic Commerce does not record imports "for consumption" in this form. Wherever exports are shown, unless otherwise specified, the figures represent domestic products and not foreign minerals reexported, and they also cover calendar years.

HISTORICAL DATA.

It is the plan of the Geological Survey to show the figures in detail by years beginning with 1880 (in form similar to table on page 19A) in Mineral Resources every fifth year. The detailed figures in this form for the early years appeared in the report for 1915 and will next be given in the report for 1920. A table and diagram showing the value of the total mineral production of the United States from 1880 to 1918 by years and separating the totals into values for metallic, nonmetallic, and unspecified products, are given on pages 26A and 27A. This table contains all the revisions made since the summary for 1915 was issued. For statistical data regarding any mineral prior to 1880, the first year for which general mineral statistics are available, the reader should consult the special chapter on the mineral concerned.

PRODUCTION BY STATES.

In the portion of this summary beginning with page 117A will be found tables showing the mineral production by States. In these tables the value of iron ore rather than pig iron has been considered the basis of iron valuation, inasmuch as the Survey does not trace back to the producing State the iron ore used in the various blast furnaces. In the case of gold, silver, copper, lead, and zinc, the value of the mine production (recoverable content of metal) is used as the basis of metal valuation. Duplication has been eliminated from the total values for these States in the same manner as outlined on page 15A with the exception of the zinc and lead pigments, all values for these pigments being excluded from the value of the total mineral production of the State, as the recoverable zinc and lead content of the ores from which the products were made is included under zinc or lead.

GENERAL REMARKS.

The total value of the mineral output of the United States during the 39 years for which general mineral statistics are available has been nearly $54,000,000,000, more than half of which was produced during the last 9 years and more than one-fourth during the last 3 years. The metals have contributed somewhat more than 40 per cent and the nonmetals nearly 60 per cent of this great total.

In 1899 for the first time the total value of the mineral production reached $1,000,000,000, in 1905 and 1906 it was more than $1,500,000,000, and in 1907 it exceeded $2,000,000,000. The total did not again reach this level until 1912, when the value was more than $2,200,000,000. It remained about the same until 1916, when, owing to the demand for increased production of war minerals and to their greater value, especially the metals, an increase of 47 per cent was made, bringing the total to more than $3,500,000,000. In 1917 a new record was established when the value increased 42 per cent and was slightly under $5,000,000,000. This increase did not mean, however, that the mines of the United States contributed in 1917 an additional 42 per cent to the mineral needs of the world. There were decreases in the production of such essential metals as copper, iron, and lead, as well as of gold and silver, and also in the production of practically all building materials and in various other products.

In 1918 a total of $5,540,000,000 was recorded, an increase of 11 per cent over the former record value. A study of the table on page 19A shows that of the 74 products for which values are given, 45 increases and 29 decreases are recorded, whereas the quantities show 43 decreases. The furnace products (pig iron and ferroalloys), together with copper, coal, and petroleum, contributed nearly $4,300,000,000, or 78 per cent of the total value of minerals produced. As heretofore, coal and iron are the most valuable of our mineral products.

Metallic products.—In 1900, for the first time, the value of metallic products reached $500,000,000. During the next six years there were depressions and recoveries in total value until 1907, when a record of $900,000,000 was established. This year continued to hold the record until 1915, when the total exceeded $990,000,000. In 1916 the value was more than $1,620,000,000, in 1917 it exceeded $2,000,000,000, and in 1918 it established a new record of $2,153,000,000, representing nearly 40 per cent of the value of all mineral products. The increase in value in 1918 over the preceding year was only 3 per cent, as compared with increases of 63 and 29 per cent, respectively, in 1916 and 1917. Of the 23 metallic products for which values are given, 14 show increases and 9 decreases, whereas in quantity conditions are practically reversed.

Nonmetallic products.—Not since 1880, the first year for which general mineral statistics are available, has the value of nonmetallic products been exceeded by the metals. The proportionate excess in value of nonmetals was greatest in 1914, when their value was more than double that of the metallic products. A total of $500,000,000 for nonmetals was reached for the first time in 1899. Steady increases, with the exception of 1904, brought the total value to $1,000,000,000 in 1906 and to more than $1,500,000,000 in 1913. Slight decrease was recorded in 1914 and continued in 1915, although in 1915 the metallic products increased 44 per cent in value. A record of $1,884,000,000 was established in 1916, but the value increased more than $1,000,000,000, or 54 per cent, to $2,900,000,000 in 1917, and exceeded $3,380,000,000, or more than 60 per cent of the value of all minerals, in 1918. Of the 51 nonmetallic minerals for which values are given in 1918, 31 increased and 20 decreased, whereas in quantity 31 decreased. On subdividing nonmetallic products, it is found that in 1918 the mineral fuels (coal, natural gas, natural-gas gasoline, and petroleum) increased about $498,000,000, or 22 per cent, in value—from nearly $2,238,000,000 in 1917 to more than $2,736,000,000 in 1918—but that the other nonmetallic products decreased slightly in value. The fuels, with the exception of anthracite and natural gas, also increased in quantity.

Unspecified products.—Because of the intermittent production of many of the unspecified products, the total values vary greatly. It has been the continuous effort of the Geological Survey to make its annual canvasses of mineral producers as nearly complete as possible, and the total values shown under "Unspecified products" contain fewer estimates during the last decade than in the earlier years. These products, valued in 1918 at $6,700,000, include the value of antimony other than content of antimonial lead ($659,484), metallic arsenic, bismuth, cadmium sulphide ($70,315), chats or tailings from Missouri zinc mines ($270,000), chert ($17,500), cobalt concentrates, columbite containing about 50 per cent of Ta_2O_5 ($2,250), a considerable production of diatomaceous earth for special uses upon which the Survey is not at liberty to report, flint lining for tube mills ($46,634), fluorspar for optical use, ilmenite ($18,600), iron ore sold for paint ($22,924), lithium minerals ($111,600), lithographic stone ($350), magnesium ($615,217), marls ($265,857), molybdenum ($1,253,700), pebbles for grinding ($82,851), selenium ($206,540), silica sand and sandstone, finely ground ($620,584), slate granules, sodium salts (carbonate, bicarbonate, and sulphate) from natural sources ($992,788), strontium ore ($20,000), and tellurium, and an estimate of the value of miscellaneous mineral products, statistics for which are not collected annually by the Geological Survey, and bring the total value of the mineral production for 1918 up to $5,540,496,000.

GENERAL TABLES.

Mineral products of the United States in 1917 and 1918.[a]

Product.	1917		1918					
					Increase or decrease.		Percentage of increase or decrease.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
METALLIC.								
Aluminum .... pounds..	....	$45,882,000	....	$41,159,000	....	− $4,723,000	....	− 10.3
Antimonial lead [b] .... short tons (2,000 pounds)..	18,646	3,781,560	18,570	2,828,350	− 76	− 955,210	− 0.4	− 25.3
Antimony [c] .... do....	5,199	[c] 2,152,386	5,183	[c] 1,306,116	− 16	− 846,270	− .3	− 39.3
Bauxite .... long tons (2,240 pounds)..	568,690	3,119,058	605,721	3,447,992	+ 37,031	+ 328,934	+ 6.5	+ 10.5
Cadmium .... pounds..	207,408	305,097	127,164	188,203	− 80,244	− 116,894	− 38.7	− 38.3
Chromite .... long tons..	43,725	1,049,400	82,430	3,955,567	+ 38,705	+ 2,906,167	+ 88.5	+ 276.9
Copper [d], sales value .... pounds..	1,886,120,721	514,911,000	1,908,533,595	471,408,000	+ 22,412,874	− 43,503,000	+ 1.2	− 8.4
Ferroalloys .... long tons..	634,021	83,731,724	750,868	115,433,943	+ 116,847	+ 31,702,219	+ 18.4	+ 37.9
Gold [e] .... troy ounces..	4,051,440	83,750,700	3,320,784	68,646,700	− 730,656	− 15,104,000	− 18.0	− 18.0
Iron:								
Ore [f] .... long tons..	75,573,207	[f] 238,260,444	72,021,202	[f] 244,368,147	− 3,552,005	+ 6,107,703	− 4.7	+ 2.6
Pig .... do....	38,612,546	1,053,785,975	38,230,440	1,180,759,565	− 382,106	+ 126,973,590	− 1.0	+ 12.0
Lead (refined), [d] sales value .... short tons..	548,450	94,333,000	539,905	76,667,000	− 8,545	− 17,666,000	− 1.6	− 18.7
Manganese ore (35 per cent or more Mn) .... long tons..	129,405	4,109,722	305,869	8,240,386	+ 176,464	+ 4,130,664	+ 136.4	+ 100.5
Manganiferous ore (5 to 35 per cent Mn) .... do....	860,944	3,406,061	1,170,462	5,635,579	+ 309,518	+ 2,229,518	+ 36.0	+ 65.5
Nickel, [g] value at New York City .... short tons..	402	331,556	441	401,000	+ 39	+ 69,444	+ 9.7	+ 20.9
Platinum and allied metals (value at New York City) .... troy ounces..	38,831	4,023,757	59,753	6,417,980	+ 20,922	+ 2,394,223	+ 53.9	+ 59.5
Quicksilver (value at San Francisco) flasks (75 pounds net).	36,159	3,808,266	32,883	3,863,752	− 3,276	+ 55,486	− 9.1	+ 1.5
Silver .... troy ounces..	71,740,362	59,078,100	67,810,139	66,485,129	− 3,930,223	+ 7,407,029	− 5.5	+ 12.5
Tin (metallic equivalent) .... short tons..	110	135,600	69	118,500	− 41	− 17,100	− 37.3	− 12.6
Titanium ore (rutile) .... do....	206	32,960	261	39,150	+ 55	+ 6,190	+ 26.7	+ 18.8
Tungsten ore (60 per cent concentrates) .... do....	6,144	6,783,000	5,061	7,049,300	− 1,083	+ 266,300	− 17.6	+ 3.9
Uranium and vanadium minerals .... do....	....	617,000	....	957,000	....	+ 340,000	....	+ 55.1
Zinc, [d] sales value .... do....	584,597	119,258,000	492,405	89,618,000	− 92,192	− 29,640,000	− 15.8	− 24.9
Total value of metallic products (approximate)	....	2,086,234,000	....	2,153,318,000	....	+ 67,084,000	....	+ 3.2

[a] Attention is called to the fact that in this general statement certain of the figures represent shipments rather than quantity mined. The reader is referred to the following sections on the various mineral products for more detailed information in this regard than it seems practicable to give here.

[b] From both domestic and foreign ores.

[c] From all sources. Values excluded from metallic totals as the values of the antimony contained in antimonial lead are included in the antimonial lead values, and the remainder under last item ("Unspecified").

[d] Product from domestic ores only.

[e] Value, $20.671834625323 an ounce.

[f] Value not included in total value.

[g] By-product in electrolytic copper refining.

Mineral products of the United States in 1917 and 1918—Continued.

Product.	1917		1918					
	Quantity.	Value.	Quantity.	Value.	Increase or decrease.		Percentage of increase or decrease.	
					Quantity.	Value.	Quantity.	Value.
NONMETALLIC.								
Arsenious oxide .... short tons..	6,151	$1,118,313	[a] 6,323	[a] $1,213,000	+ 172	+ $94,687	+ 2.8	+ 8.5
Asbestos .... do....	1,683	506,056	1,002	124,687	− 681	− 381,369	− 40.5	− 75.4
Asphalt .... do....	[b] 783,413	[b] 8,508,115	587,609	8,216,012	− 195,804	− 292,103	− 25.0	− 3.4
Barytes (crude) .... do....	206,888	1,171,184	155,368	1,044,905	− 51,520	− 126,279	− 24.9	− 10.8
Borates .... do....	108,875	3,609,632	88,794	2,263,230	− 20,081	− 1,346,402	− 18.4	− 37.3
Bromine .... pounds..	895,499	492,703	1,727,156	970,099	+ 831,657	+ 477,396	+ 92.9	+ 96.9
Calcium-magnesium chloride .... short tons..	30,503	451,480	26,624	503,452	− 3,879	+ 51,972	− 12.7	+ 11.5
Cement .... barrels (376 pounds net)..	91,342,930	123,210,458	71,348,474	113,554,854	− 19,994,456	− 9,655,604	− 21.9	− 7.8
Clay:								
Products	....	[b] 232,512,773	....	221,884,651	....	− 10,628,122	....	− 4.6
Raw [c] .... short tons..	3,113,844	[c] 8,042,546	2,976,361	[c] 8,332,641	− 137,483	+ 290,095	− 4.4	+ 3.6
Coal:								
Bituminous [d] .... do....	551,790,563	1,249,272,837	579,385,820	1,491,809,940	+ 27,595,257	+ 242,537,103	+ 5.0	+ 19.4
Pennsylvania anthracite .... long tons..	88,939,117	283,650,723	88,237,575	336,480,347	− 701,542	+ 52,829,624	− .8	+ 18.6
Coke [c] .... short tons..	55,606,828	[c] 298,243,017	56,478,372	[c] 382,324,368	+ 871,544	+ 84,081,351	+ 1.6	+ 28.2
Diatomaceous (infusorial) earth and tripoli .... do....	[e] 29,102	[b e] 369,556	[e] 22,947	[e] 224,801	− 6,155	− 144,755	− 21.1	− 39.2
Emery and corundum .... do....	17,135	241,050	10,422	112,878	− 6,713	− 128,172	− 39.2	− 53.2
Feldspar .... do....	141,924	728,838	99,120	674,346	− 42,804	− 54,492	− 30.2	− 7.5
Fluorspar .... do....	218,828	2,287,722	263,817	5,465,481	+ 44,989	+ 3,177,759	+ 20.6	+ 138.9
Fuller's earth .... do....	72,567	772,087	84,468	1,146,354	+ 11,901	+ 374,267	+ 16.4	+ 48.5
Garnet for abrasive purposes .... do....	4,995	198,327	4,696	248,161	− 299	+ 49,834	− 6.0	+ 25.1
Gems and precious stones	....	131,012	....	106,523	....	− 24,489	....	− 18.7
Graphite:								
Amorphous .... short tons..	8,301	73,481	6,560	69,455	− 1,741	− 4,026	− 21.0	− 5.5
Crystalline .... pounds..	10,584,080	1,094,398	12,861,839	1,454,799	+ 2,277,759	+ 360,401	+ 21.5	+ 32.9
Grindstones and pulpstones .... short tons..	....	1,147,784	65,339	1,776,282	....	+ 628,498	....	+ 54.8
Gypsum .... do....	2,696,226	11,116,452	2,057,015	11,470,854	− 639,211	+ 354,402	− 23.7	+ 3.2
Lime .... do....	3,786,364	23,807,877	3,206,016	26,808,909	− 580,318	+ 3,001,032	− 15.3	+ 12.6
Magnesite (crude) .... do....	316,838	2,899,818	231,605	1,812,601	− 85,233	− 1,087,217	− 26.9	− 37.5
Mica:								
Scrap .... do....	3,429	52,908	2,292	33,130	− 1,137	− 19,778	− 33.2	− 37.4
Sheet .... pounds..	1,276,533	753,874	1,644,200	731,810	+ 367,667	− 22,064	+ 28.8	− 2.9
Millstones	....	43,489	....	92,514	....	+ 49,025	....	+ 112.7
Mineral paints:								
Natural pigments [f] .... short tons..	([f])	([f])	([f])	([f])	([f])	([f])	([f])	([f])
Zinc and lead pigments [g] .... do....	140,636	26,972,137	135,746	26,464,590	− 4,890	− 507,547	− 3.5	− 1.9
Mineral waters .... gallons sold..	46,784,419	4,931,710	40,709,722	4,533,001	− 6,074,697	− 398,709	− 13.0	− 8.1
Natural gas .... M cubic feet..	795,110,376	142,089,334	721,000,959	153,553,560	− 74,109,417	+ 11,464,226	− 9.3	+ 8.1
Natural-gas gasoline .... gallons..	217,884,104	40,188,956	282,535,550	50,363,535	+ 64,651,446	+ 10,174,579	+ 29.7	+ 25.3
Oilstones, etc .... short tons..	1,816	168,704	1,010	189,033	− 806	+ 20,329	− 44.4	+ 12.1

Peat...do.	97,363	709,900	107,261	1,047,243	+ 9,898	+ 337,343	+ 10.2	+ 47.5
Petroleum...barrels (42 gallons)	335,315,601	522,635,213	355,927,716	703,943,961	+ 20,612,115	+ 181,308,748	+ 6.1	+ 34.7
Phosphate rock...long tons	2,584,287	7,771,084	2,490,760	8,214,463	− 93,527	+ 443,379	− 3.6	+ 5.7
Potash (K_2O)...short tons	32,573	13,980,577	38,580	15,839,618	+ 6,007	+ 1,859,041	+ 18.4	+ 13.3
Pumice...do.	35,293	84,814	30,637	91,178	− 4,656	+ 6,364	− 13.2	+ 7.5
Pyrites...long tons	[b] 482,662	[b] 2,593,035	464,494	2,644,515	− 18,168	+ 51,480	− 3.8	+ 2.0
Salt...short tons	6,978,177	19,940,442	7,238,744	26,940,361	+ 260,567	+ 6,999,919	+ 3.7	+ 35.1
Sand:								
Glass...do.	1,942,675	2,685,014	2,172,887	4,209,728	+ 230,212	+ 1,524,714	+ 11.9	+ 56.8
Molding, building, etc., and gravel...do.	74,476,650	32,611,918	59,651,539	33,717,351	− 14,825,111	+ 1,105,433	− 19.9	+ 3.4
Sand-lime brick...thousands	187,546	1,420,330	98,399	883,929	− 89,147	− 536,401	− 47.5	− 37.8
Silica (quartz)...short tons	142,673	318,069	71,740	259,330	− 70,933	− 58,739	− 49.7	− 18.5
Slate...	...	5,749,966	...	[h] 4,038,770	...	− [h] 1,711,196	...	− [h] 29.8
Stone...short tons	[b] 83,574,900	82,215,671	68,563,360	82,700,430	− 15,011,540	+ 484,759	− 18.0	+ .6
Sulphur...long tons	1,120,378	23,987,000	1,266,709	27,868,000	+ 146,331	+ 3,881,000	+ 13.1	+ 16.2
Sulphuric acid (60° Baumé) from copper and zinc smelters...short tons	[i] 1,455,257	16,890,545	(j)	(j)	(j)	(j)	(j)	(j)
Talc and soapstone (exclusive of fibrous talc)...do.	144,177	1,411,416	137,140	1,778,919	− 7,037	+ 367,503	− 4.9	+ 26.0
Talc, fibrous...do.	74,671	881,462	71,167	902,100	− 3,504	+ 20,638	− 4.7	+ 2.3
Thorium minerals (monazite)...pounds	22,000	1,760	...	...	− 22,000	− 1,760	− 100.0	− 100.0
Total value of nonmetallic products (approximate)	...	2,900,462,000	...	3,380,478,000	...	+ [k] 480,016,000	...	+ [k] 16.5
SUMMARY.								
Total value of metallic products	...	2,086,234,000	...	2,153,318,000	...	+ 67,084,000	...	+ 3.2
Total value of nonmetallic products (exclusive of mineral fuels)	...	662,625,000	...	644,327,000	...	− [k] 18,298,000	...	− [k] 2.8
Total value of mineral fuels	...	2,237,837,000	...	2,736,151,000	...	+ 498,314,000	...	+ 22.3
Total value of "unspecified" (metallic and nonmetallic) products (partly estimated) [l]	...	5,800,000	...	[l] 6,700,000	...	+ 900,000	...	+ 15.5
Grand total approximate value of all mineral products	...	4,992,496,000	...	5,540,496,000	...	+ [k] 548,000,000	...	+ [k] 11.0

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[a] In addition to arsenious oxide (white arsenic), metallic arsenic was produced in 1918. The value of this metallic arsenic is included under last item ("Unspecified").

[b] Revised figures.

[c] Value not included in total value.

[d] Includes brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania.

[e] Exclusive of considerable production for special uses which is included under last item ("Unspecified").

[f] Canvass discontinued after 1915. Value of iron ore sold for paint included under last item ("Unspecified").

[g] Sublimed blue lead, sublimed white lead, leaded zinc oxide, and zinc oxide.

[h] Exclusive of value of slate granules which is included under last item ("Unspecified"). **Figures for 1917 and 1918 not strictly comparable as Survey not at liberty to publish as heretofore.**

[i] Includes 119,048 tons of stronger acid, reported as oleum, etc., not converted to 60° Baumé.

[j] Canvass discontinued after 1917.

[k] Canvass of sulphuric acid from copper and zinc smelters discontinued after 1917. If the value of this acid were excluded from the 1917 totals, the increase in nonmetallic products would be $496,906,000 (17.2 per cent); the decrease in nonmetallic products, other than mineral fuels, $1,408,000 (0.2 per cent); and the increase in value of all mineral products, $564,891,000 (11.4 per cent).

[l] Includes in 1918 products as follows: Antimony other than content of antimonial lead, valued at $659,484, metallic arsenic, bismuth, cadmium sulphide ($70,315), chats ($270,000), chert ($17,500), cobalt concentrates, columbite containing about 50 per cent of Ta_2O_5 ($2,250), diatomaceous earth for special uses, flint lining for tube mills ($46,634,) fluorspar for optical use, ilmenite ($18,600), iron ore sold for paint ($22,924), lithium minerals ($111,600), lithographic stone ($350), magnesium ($615,217), marls ($265,857), molybdenum ($1,253,700), pebbles for grinding ($82,851), selenium ($206,540), silica sand and sandstone, finely ground ($620,584), slate granules, sodium salts (carbonate, bicarbonate, and sulphate) from natural sources ($992,788), strontium ore ($20,000), tellurium, and an estimate of the value of miscellaneous mineral products, statistics for which are not collected annually by the Survey.

Principal metals, fuels, and structural materials produced in the United States, 1917 and 1918.

Mineral.	Principal producing States in 1918 (in order of value).[a]	1917			1918			Increase or decrease in value.			
								By minerals.		By groups.	
		Quantity.	Value.	Value by groups.	Quantity.	Value.	Value by groups.	Amount.	Per cent.	Amount.	Per cent.
Metals (from domestic ores):											
Pig iron, long tons..	Pennsylvania, Ohio, Illinois, Alabama.	38,107,330	$1,039,404,779	$1,910,735,579	37,778,140	$1,164,836,165	$1,937,660,994	+$125,431,386	+12.1	+$26,925,415	+ 1.4
Copper....pounds..	Arizona, Montana, Utah, Michigan.	1,886,120,721	514,911,000		1,908,533,595	471,408,000		− 43,503,000	− 8.4		
Zinc....short tons..	Oklahoma, Montana, New Jersey, Missouri.	584,597	119,258,000		492,405	89,618,000		− 29,640,000	−24.9		
Lead.......do.....	Missouri, Idaho, Utah, Oklahoma.	548,450	94,333,000		539,905	76,667,000		− 17,666,000	−18.7		
Gold..troy ounces..	California, Colorado, Alaska, Nevada.	4,051,440	83,750,700		3,320,784	68,646,700		− 15,104,000	−18.0		
Silver,......do.....	Montana, Utah, Nevada, Idaho.	71,740,362	59,078,100		67,810,139	66,485,129		+ 7,407,029	+12.5		
Fuels:											
Coal....short tons..	Pennsylvania, West Virginia, Illinois, Ohio.	651,402,374	1,532,923,560	2,237,837,063	678,211,904	1,828,290,287	2,736,151,343	+ 295,366,727	+19.3	+498,314,280	+22.3
Petroleum.barrels..	Oklahoma, California, Kansas, Texas.	335,315,601	522,635,213		355,927,716	703,943,961		+ 181,308,748	+34.7		
Natural gas, M cubic feet.	West Virginia, Pennsylvania, Ohio, Oklahoma.	795,110,376	142,089,334		721,000,959	153,553,560		+ 11,464,226	+ 8.1		
Natural-gas gasoline, gallons.	Oklahoma, West Virginia, California, Pennsylvania.	217,884,104	40,188,956		282,535,550	50,363,535		+ 10,174,579	+25.3		

Structural materials:											
Clay products (brick and tile).	Pennsylvania, Ohio, Illinois, Missouri.	....	176,350,251	457,747,607	....	156,661,700	433,162,596	− 19,688,551	−11.2	− 24,585,011	− 5.4
Cement....barrels..	Pennsylvania, Indiana, Missouri, California.	91,342,930	123,210,458		71,348,474	113,554,854		− 9,655,604	− 7.8		
Stone...short tons..	Pennsylvania, Ohio, Vermont, Michigan.	83,574,900	82,215,671		68,563,360	82,700,430		+ 484,759	+ .6		
Sand and gravel, short tons.	Pennsylvania, Ohio, Illinois, New Jersey.	76,419,325	35,296,932		61,824,426	37,927,079		+ 2,630,147	+ 7.5		
Lime...short tons..	Pennsylvania, Ohio, Missouri, Virginia.	3,786,364	23,807,877		3,206,016	26,808,909		+ 3,001,032	+12.6		
Gypsum.....do....	New York, Iowa, Michigan, Ohio.	2,696,226	11,116,452		2,057,015	11,470,854		+ 354,402	+ 3.2		
Slate..............	Pennsylvania, Vermont, Maine, Virginia.	....	5,749,966		....	[b] 4,038,770		− 1,711,196	−29.8		

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[a] Rank of States in metal production (except pig iron) arranged according to mines reports, not smelter output.

[b] Exclusive of value of slate granules.

Mineral products of the United States in 1918, in order of value.

Rank.		Mineral.	Principal producing States.[a]		Value.	Percentage of total value for United States.
1917	1918		In order of quantity.	In order of value.		
1	1	Coal:				
		Bituminous	Pennsylvania, West Virginia, Illinois, Ohio	Rank same as for quantity	$1,491,809,940	26.93
		Pennsylvania anthracite	Pennsylvania	do	336,480,347	6.07
2	2	Iron, pig	Pennsylvania, Ohio, Illinois, Alabama	do	1,180,759,565	21.31
3	3	Petroleum	Oklahoma, California, Kansas, Texas	do	703,943,961	12.71
4	4	Copper	Arizona, Montana, Utah, Michigan	do	471,408,000	8.51
5	5	Coke	Pennsylvania, Ohio, Alabama, Indiana	Pennsylvania, Ohio, Indiana, Alabama	[b]382,324,368	(b)
7	6	Iron ore	Minnesota, Michigan, Alabama, Wisconsin	Minnesota, Michigan, Alabama, New York	[b]244,368,147	(b)
6	7	Clay products		Ohio, Pennsylvania, New Jersey, Illinois	221,884,651	4.01
8	8	Natural gas	West Virginia, Oklahoma, Pennsylvania, Ohio	West Virginia, Pennsylvania, Ohio, Oklahoma	153,553,560	2.77
13	9	Ferroalloys	Pennsylvania, Ohio, New York, Virginia	Pennsylvania, New York, Virginia, Alabama	115,433,943	2.08
9	10	Cement	Pennsylvania, Indiana, Missouri, California	Rank same as for quantity	113,554,854	2.05
10	11	Zinc	Oklahoma, Montana, New Jersey, Missouri	do	89,618,000	1.62
14	12	Stone	Quantities by States not available	Pennsylvania, Ohio, Vermont, Michigan	82,700,430	1.49
11	13	Lead	Missouri, Idaho, Utah, Oklahoma	Rank same as for quantity	76,667,000	1.38
12	14	Gold	California, Colorado, Alaska, Nevada	do	68,646,700	1.24
15	15	Silver	Montana, Utah, Nevada, Idaho	do	66,485,129	1.20
17	16	Natural-gas gasoline	Oklahoma, West Virginia, California, Pennsylvania.	do	50,363,535	.91
16	17	Aluminum		New York, North Carolina, Tennessee	41,159,000	.74
18	18	Sand and gravel	Illinois, Pennsylvania, Ohio, Indiana	Pennsylvania, Ohio, Illinois, New Jersey	37,927,079	.68
20	19	Sulphur	Louisiana, Texas, Nevada, Colorado	Rank same as for quantity	27,868,000	.50
22	20	Salt	Michigan, New York, Ohio, Kansas	Michigan, New York, Kansas, Ohio	26,940,361	.49
21	21	Lime	Pennsylvania, Ohio, Virginia, Missouri	Pennsylvania, Ohio, Missouri, Virginia	26,808,909	.48
19	22	Mineral paints (zinc and lead pigments).	Pennsylvania, Kansas, Missouri, Illinois	Pennsylvania, Kansas, Missouri, Wisconsin	26,464,590	.48
23	23	Potash (K_2O)	California, Nebraska, Utah, Maryland	California, Nebraska, Utah, Wisconsin	15,839,618	.29
24	24	Gypsum	New York, Iowa, Michigan, Ohio	Rank same as for quantity	11,470,854	.21
26	25	Clay, raw	Pennsylvania, Missouri, Ohio, New Jersey	Pennsylvania, Missouri, New Jersey, Ohio	[b]8,332,641	(b)
31	26	Manganese ore	Montana, California, Nevada, Arizona	Montana, California, Arizona, Nevada	8,240,386	.15
25	27	Asphalt	California, Oklahoma, Texas, Illinois	California, Texas, Oklahoma, Illinois	8,216,012	.15
27	28	Phosphate rock	Florida, Tennessee, South Carolina, Idaho	Florida, Tennessee, South Carolina, Kentucky	8,214,463	.15
28	29	Tungsten ore	Colorado, California, Nevada, Arizona	California, Colorado, Nevada, Arizona	7,049,300	.12
32	30	Platinum and allied metals	California, Alaska, Wyoming, Nevada	Rank same as for quantity	6,417,980	.12
36	31	Manganiferous ore	Minnesota, Colorado, Nevada, New Mexico	Minnesota, Colorado, New Mexico, Virginia	5,635,579	.10
41	32	Fluorspar	Illinois, Kentucky, Colorado, New Mexico	Rank same as for quantity	5,465,481	.10

30	33	Mineral waters	Wisconsin, New York, Ohio, California	Wisconsin, New York, California, Maine	4,533,001	.84
29	34	Slate		Pennsylvania, Vermont, Maine, Virginia	[c] 4,038,770	
48	35	Chromite	California, Oregon, Alaska, Maryland	California, Oregon, Alaska, North Carolina	3,955,567	
33	36	Quicksilver	California, Texas, Nevada, Oregon	Rank same as for quantity	3,863,752	
37	37	Bauxite	Arkansas, Georgia, Alabama, Tennessee	do	3,447,992	
34	38	Antimonial lead	Not separable by States	Not separable by States	2,826,350	
40	39	Talc and soapstone	Vermont, New York, Virginia, California	New York, Vermont, Virginia, California	2,681,019	
39	40	Pyrites	Virginia, California, New York, Georgia	Rank same as for quantity	2,644,515	
35	41	Borates	California	do	2,263,230	
38	42	Magnesite (crude)	Washington, California	do	1,812,601	
46	43	Grindstones and pulpstones	Ohio, West Virginia, Michigan	do	1,776,282	
45	44	Graphite	Alabama, New York, Pennsylvania, Texas	Alabama, New York, Pennsylvania, Rhode Island	1,524,254	
42	45	Antimony[d]	Nevada, Idaho, Alaska	Rank same as for quantity	[d] 1,306,116	
47	46	Arsenious oxide	Not separable by States	Not separable by States	1,213,000	
50	47	Fuller's earth	Florida, Texas, Georgia, California	Florida, Texas, Georgia, Arkansas	1,146,354	
52	48	Peat	New Jersey, Illinois, California, Massachusetts	New Jersey, Illinois, Massachusetts, California	1,047,243	
44	49	Barytes (crude)	Georgia, Missouri, Tennessee, Kentucky	Rank same as for quantity	1,044,905	
55	50	Bromine	Michigan, West Virginia, Ohio	do	970,099	
53	51	Uranium and vanadium minerals		Colorado, Utah, Wyoming, Nevada	957,000	
43	52	Sand-lime brick	Michigan, Minnesota, Pennsylvania, Indiana	Michigan, Pennsylvania, Minnesota, New York	883,929	
49	53	Mica		North Carolina, New Hampshire, Georgia, Virginia	764,940	
51	54	Feldspar	North Carolina, Maine, New York, Maryland	Maine, North Carolina, New York, Pennsylvania	674,346	
56	55	Calcium chloride	Michigan, West Virginia, Ohio, California	Rank same as for quantity	503,452	
57	56	Nickel	Not separable by States	Not separable by States	401,000	
58	57	Silica (quartz)	Tennessee, Maryland, Connecticut, Massachusetts	Connecticut, Maryland, Tennessee, Wisconsin	259,330	
61	58	Garnet for abrasive purposes	New York, New Hampshire, North Carolina	Rank same as for quantity	248,161	
65	59	Diatomaceous (infusorial) earth and tripoli.	California, Illinois, Missouri, Washington	California, Illinois, Missouri, Pennsylvania	[e] 224,801	
62	60	Oilstones, etc	Arkansas, Indiana, Ohio, Vermont	Rank same as for quantity	189,073	
59	61	Cadmium	Not separable by States	Not separable by States	188,203	
54	62	Asbestos	Georgia, North Carolina, California, Arizona	Arizona, California, Maryland, Georgia	124,687	
63	63	Tin	Alaska, South Carolina, South Dakota	Rank same as for quantity	118,500	
60	64	Emery and corundum	New York, Virginia, North Carolina	New York, North Carolina, Virginia	112,878	
64	65	Gems and precious stones		Montana, Nevada, California, Arizona	106,523	
67	66	Millstones		North Carolina, Virginia, New York, Maryland	92,514	
66	67	Pumice	Kansas, Nebraska, California	Kansas, California, Nebraska	91,178	
68	68	Titanium ore (rutile)	Virginia	Rank same as for quantity	39,150	
		"Unspecified" products			6,700,000	.12
		Grand total (approximate)		Pennsylvania, Oklahoma, West Virginia, Illinois, Ohio, California, Arizona.	5,540,496,000	100.00

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[a] Rank of States in metal production (except pig iron, ferroalloys, and aluminum) arranged according to mines reports, not smelter output.

[b] Value not included in total for United States.

[c] Exclusive of value of slate granules which is included under last item ("Unspecified").

[d] Value excluded from total, except value of antimony other than that entering into antimonial lead which is included under last item ("Unspecified"). States are arranged in order of antimony ore produced.

[e] Exclusive of considerable production for special uses which is included under last item ("Unspecified").

Prices of silver, copper, lead, and zinc, 1909–1918.

Year.	Silver.[a]	Copper.[b]	Lead.[c]	Zinc.[d]	Year.	Silver.[a]	Copper.[b]	Lead.[c]	Zinc.[d]
	Troy oz.	*Pound.*	*Pound.*	*Pound.*		*Troy oz.*	*Pound.*	*Pound.*	*Pound.*
1909	$0.52	$0.13	$0.043	$0.054	1914	$0.553	$0.133	$0.039	$0.051
1910	.54	.127	.044	.054	1915	.507	.175	.047	.124
1911	.53	.125	.045	.057	1916	.658	.246	.069	.134
1912	.615	.165	.045	.069	1917	.824	.273	.086	.102
1913	.604	.155	.044	.056	1918	[e].98	.247	.071	.091

[a] Average price furnished by Bureau of the Mint.

[b] For 1909–1915, U. S. Geological Survey computation for electrolytic copper based on quotations by technical journals. For 1916 and later years, average sales price all marketable grades.

[c] For 1909–1915, New York price, U. S. Geological Survey computation from daily market spot quotations. For 1916, from outside spot quotations at New York. For 1917 and later years, average sales price.

[d] For 1909–1914, St. Louis price, U. S. Geological Survey computation from daily market spot quotations. For 1915 and later years average sales price all grades.

[e] Price given by Bureau of Mint early in 1919 as the approximate average selling price of all silver sold in 1918 was $1 a troy ounce, and this price was used by the Geological Survey in computing value of mine production of silver in State tables, pp. 120A to 145A. The price of 98 cents a troy ounce, later given by the Mint, has been used in computing value of smelter output of silver in all Mint-Survey cooperative tables.

Total value of mineral products of the United States from 1880 to 1918.

Year.	Metallic.		Nonmetallic.		Unspecified (metallic and nonmetallic).	Total.	
	Value.	Percentage of increase or decrease.	Value.	Percentage of increase or decrease.		Value.	Percentage of increase or decrease.
1880	$187,881,000	....	$173,582,000	....	$6,000,000	$367,463,000	....
1881	189,413,000	+ 0.8	207,207,000	+ 19	6,500,000	403,120,000	+ 10
1882	215,820,000	+ 14	230,786,000	+ 11	6,500,000	453,106,000	+ 12
1883	197,881,000	− 8	243,680,000	+ 6	6,500,000	448,061,000	− 1
1884	180,284,000	− 9	221,756,000	− 9	5,000,000	407,040,000	− 9
1885	172,218,000	− 4	242,333,000	+ 9	5,000,000	419,551,000	+ 3
1886	204,400,000	+ 19	250,995,000	+ 4	790,000	456,185,000	+ 9
1887	240,791,000	+ 18	294,057,000	+ 17	785,000	535,633,000	+ 17
1888	242,010,000	+ .5	310,889,000	+ 6	900,000	553,799,000	+ 3
1889	250,325,000	+ 3	291,004,000	− 6	997,000	542,326,000	− 2
1890	303,440,000	+ 21	310,995,000	+ 7	994,000	615,429,000	+ 13
1891	280,485,000	− 8	319,364,000	+ 3	1,000,000	600,849,000	− 2
1892	283,715,000	+ 1	337,517,000	+ 6	1,000,000	622,232,000	+ 4
1893	223,154,000	− 21	321,339,000	− 5	1,000,000	545,493,000	− 12
1894	186,835,000	− 16	362,410,000	+ 13	1,000,000	550,245,000	+ .9
1895	248,033,000	+ 33	393,658,000	+ 9	1,000,000	642,691,000	+ 17
1896	252,075,000	+ 2	387,966,000	− 1	1,000,000	641,041,000	− .3
1897	269,934,000	+ 7	380,678,000	− 2	1,000,000	651,612,000	+ 2
1898	308,247,000	+ 14	417,795,000	+ 10	1,000,000	727,042,000	+ 12
1899	483,521,000	+ 57	525,575,000	+ 26	1,000,000	1,010,096,000	+ 39
1900	513,732,000	+ 6	594,204,000	+ 13	1,000,000	1,108,936,000	+ 10
1901	493,314,000	− 4	660,764,000	+ 11	1,000,000	1,155,078,000	+ 4
1902	604,517,000	+ 23	722,434,000	+ 9	1,000,000	1,327,951,000	+ 15
1903	588,753,000	− 3	905,628,000	+ 25	1,000,000	1,495,381,000	+ 13
1904	501,114,000	− 15	857,667,000	− 5	400,000	1,359,181,000	− 9
1905	702,585,000	+ 40	920,780,000	+ 7	400,000	1,623,765,000	+ 19
1906	886,180,000	+ 26	1,014,500,000	+ 10	200,000	1,900,880,000	+ 17
1907	904,108,000	+ 2	1,165,376,000	+ 15	86,000	2,069,570,000	+ 9
1908	550,768,000	− 39	1,040,761,000	− 11	244,000	1,591,773,000	− 23
1909	754,944,000	+ 37	1,131,866,000	+ 9	297,000	1,887,107,000	+ 19
1910	749,879,000	− .7	1,237,668,000	+ 9	297,000	1,987,844,000	+ 5
1911	680,907,000	− 9	1,242,942,000	+ .4	232,000	1,924,081,000	− 3
1912	862,008,000	+ 27	1,375,420,000	+ 11	366,000	2,237,794,000	+ 16
1913	878,869,000	+ 2	1,554,298,000	+ 13	378,000	2,433,545,000	+ 9
1914	686,639,000	− 22	1,424,063,000	− 8	470,000	2,111,172,000	− 13
1915	991,730,000	+ 44	1,400,484,000	− 2	2,430,000	2,394,644,000	+ 13
1916	1,620,745,000	+ 63	1,884,413,000	+ 35	3,281,000	3,508,439,000	+ 47
1917	2,086,234,000	+ 29	2,900,462,000	+ 54	5,800,000	4,992,496,000	+ 42
1918	2,153,318,000	+ 3	3,380,478,000	+ 17	6,700,000	5,540,496,000	+ 11
Grand total	22,130,806,000	....	31,637,794,000	....	74,547,000	53,843,147,000	....

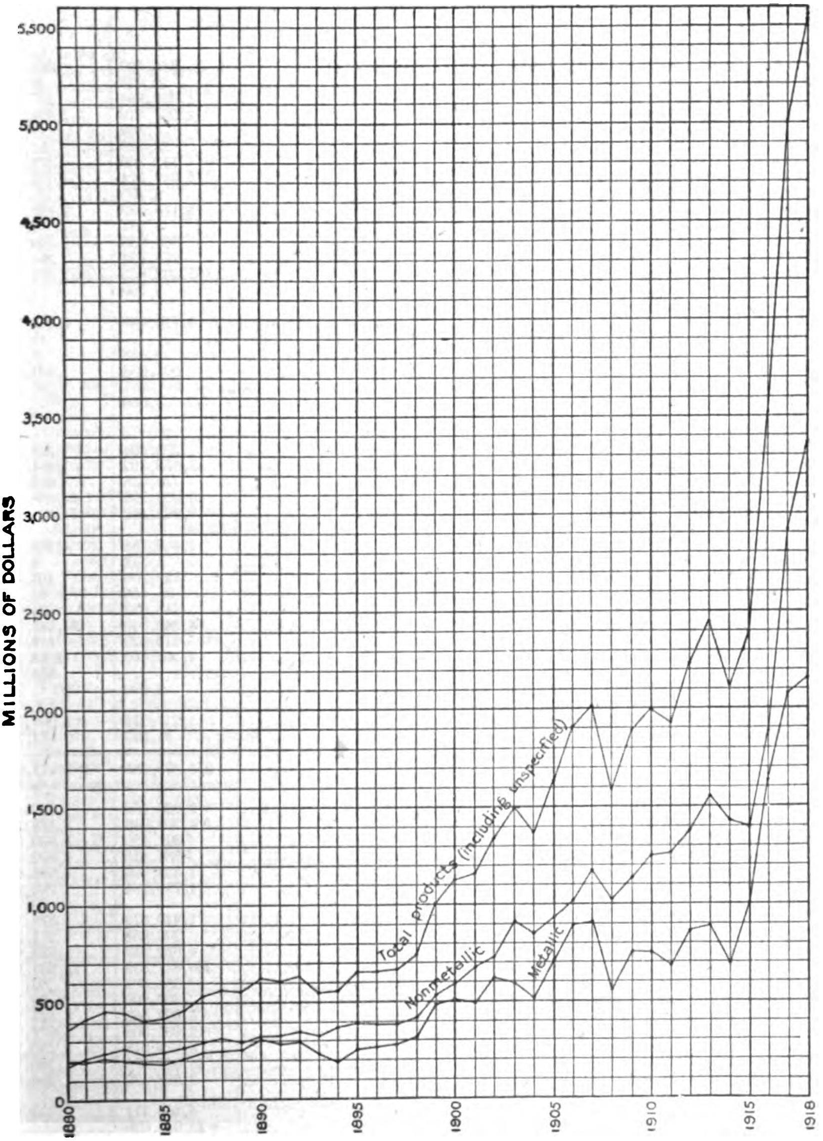

FIGURE A.—Value of mineral products of the United States, 1880-1918.

Value of imports for consumption and of exports of mineral products in the calendar years 1917 and 1918.

	1917	1918
METALLIC PRODUCTS.		
Imports.		
Aluminum:		
Crude, plates, sheet, leaf, wire, utensils, and manufactures of	$56,890	$554,586
Aluminum salts	39,088	18,519
Antimony (crude and ore)	1,006,884	177,731
Antimony (metal or regulus)	2,957,819	3,178,877
Antimony (oxide and salts)	5,368	11,904
Bauxite, crude	28,989	14,791
Bismuth	142,300	277,273
Brass, fit only for remanufacture	9,949,524	1,773,789
Cerium, cerite, or cerium ore	6,700	
Chromic iron ore	1,110,659	2,892,825
Chromium salts	5,037	3,049
Cobalt, and cobalt ore and zaffer	369,950	628,099
Oxide of	275,821	291,699
Copper, in ore, matte, ingots, bars, manufactures	135,233,853	131,379,189
Copper, sulphate of, or blue vitriol	9,799	5
Ferroalloys:		
Ferromanganese	5,710,988	4,258,745
Ferromolybdenum (and molybdenum)		19,280
Ferrophosphorus	5,458	1,055
Ferrosilicon	691,684	424,932
Ferrotitanium (and titanium)		10
Ferrotungsten (and tungsten)	3,606	8
Iron:		
Kentledge		326
Spiegeleisen	291,594	228,012
Ore	3,655,392	3,464,304
Lead, in ore, base bullion, pigs, sheets, etc	776,638	618,191
Manganese, oxide and ore of	10,262,929	15,095,867
Nickel, in ore, matte, oxide, etc	9,662,411	11,636,018
Platinum, and allied metals:		
Ore and unmanufactured	2,408,188	4,949,855
Vases, retorts, all other	1,347	8,597
Iridium, osmium, palladium, rhodium, and ruthenium	522,206	163,135
Osmiridium	25,456	46,321
Quicksilver	448,032	533,622
Tin, bars, blocks, pigs	63,860,340	93,144,218
Scrap (tin plate)	114,029	119,591
Tungsten-bearing ore	4,465,590	11,52,218
Type metal		355,938
Uranium salts and oxide, including radium salts	2,930	274
Uranium-radium steel-hardening ores		[b] 4,840
Zinc, in ore, pigs, sheets, dust, manufactures	1,217,211	1,099,572
Zinc oxide	53,525	63,746
	255,378,235	288,671,011
Exports.		
Aluminum and manufactures	[a] 9,029,458	
Ingots metal and alloys	[b] 4,269,643	7,478,149
Plates and sheets	[b] 301,550	1,500,903
All other manufactures of	[b] 985,816	1,890,336
Bauxite concentrates	1,323,926	1,523,688
Brass, scrap and old	1,758,384	799,318
Copper:		
Ore	1,410,072	578,165
Concentrates, matte, and regulus	205,888	211,392
Unrefined, black blister in pigs, bars, etc	4,614,843	3,825,606
Refined copper in ingots, pigs, bars, etc	306,847,639	178,831,041
Composition metal	[b] 350,561	60,128
Old and scrap	300,609	60,733
Pipes and tubes	[b] 3,023,563	1,845,222
Plates and sheets	12,995,503	5,677,408
Wire, except insulated	8,975,078	4,750,942
All other manufactures	16,957,876	5,286,143
Copper, sulphate of (blue vitriol)	3,038,380	1,395,946
Iron:		
Ore	4,464,111	5,535,090
Pig	[a] 12,998,026	
Ferromanganese	[b] 498,402	806,087
Ferrosilicon	[b] 719,626	443,456
All other	[b] 9,820,997	10,327,178
Scrap and old for remanufacture	3,362,562	63,626
Ferrovanadium	2,953,260	1,774,062
Tungsten and ferrotungsten	4,122,653	2,545,087

[a] Figures cover period January to June. Classification changed July 1.

[b] Classification changed July 1. Figures cover period July to December.

Value of imports for consumption and of exports of mineral products in the calendar years 1917 and 1918—Continued.

	1917	1918
METALLIC PRODUCTS—continued.		
Exports—Continued.		
Lead, bars, etc	$9,560,598	$5,889,581
Other manufactures of	2,287,305	1,824,126
Nickel, nickel oxide, and matte	8,936,620	6,927,041
Manufactures of	1,527,853	2,152,692
Platinum:		
Unmanufactured	234,433	13,511
Manufactured	65,415	23,562
Quicksilver	998,470	338,620
Tin, in pigs, bars	232,401	31,952
Zinc:		
Ore	63,043	2,480
Dross	2,126,909	2,238,913
Spelter	82,605,767	12,469,622
Rolled in sheets	5,730,792	4,566,756
All other manufactures of	570,352	722,671
	480,267,884	274,411,033
NONMETALLIC PRODUCTS.		
Imports.		
Arsenic, sulphide, etc	674,875	1,281,812
Sheep dip	15,848	23,538
Asbestos:		
Unmanufactured	4,521,172	6,337,608
Manufactured	15,646	3,132
All other	47,041	23,154
Asphalt	993,115	627,495
Barium products:		
Manufactured barytes	1,743	....
Lithopone (includes zinc sulphide)	35,718	993
Barium carbonate—		
Natural	17,321	14,134
Manufactured	1,554	....
Blanc-fixe	3,333	....
Barytes, crude	63	....
Borax and boracic acid	21,206	26,487
Burrstones and millstones	18,227	20,017
Cement, hydraulic	6,076	1,200
Chalk:		
Crude	126,605	113,985
Ground or unground	6,241	5,829
Precipitated	29,980	34,273
Cubes, blocks, sticks, tailor's, etc	6,563	4,687
French, cut, powdered, washed, etc	222	2,378
Manufactures of	340	617
Clay and clay products:		
Kaolin or china clay	1,315,769	1,153,240
Other than kaolin	126,290	165,554
Brick and tile	307,802	290,044
Flattening stones	1,457	576
Pipes, common tobacco pipes, and pipe bowls of clay	8,209	4,716
Potters, etc	6,325,105	6,388,864
Coal:		
Anthracite	18,155	203,798
Bituminous	4,823,478	6,694,668
Coke	146,451	221,880
Corundum and emery	210,602	614,167
Cryolite	218,500	97,500
Diatomaceous earth, rotten stone, and tripoli	17,864	11,128
Fulminates, fulminating powders, etc.:		
Suitable for miners	75,839	....
All other	1,848,802	197,940
Gunpowder and all other substances	2,539,249	12,886,196
Mining, blasting, or safety fuses of all kinds	5,016	869,494
Percussion caps	525	113,437
Bombs, rockets, Roman candles, and fireworks	3,413	....
Firecrackers	384,696	64,597
Fertilizers:		
Crude guano, manure salts, phosphate	171,139	280,544
Potassium chloride	158,410	102,109
Potassium sulphate	21,702	15,329
Other potassium salts	1,034,284	809,799
Sodium nitrate	60,727,100	90,216,935
Flint, flints, and flint stones	197,156	127,808
Fluorspar	114,598	169,364
Fuller's earth	176,417	165,535
Gems and precious stones (including diamond dust and bort)	34,846,351	22,666,839
Granite	35,042	10,981

Value of imports for consumption and of exports of mineral products in the calendar years 1917 and 1918—Continued.

	1917	1918
NONMETALLIC PRODUCTS—continued.		
Imports—Continued.		
Graphite	$8,961,988	$3,092,475
Grindstones, finished and unfinished	57,950	27,361
Gypsum	381,252	126,797
Keenes cement or other cement of which gypsum is the chief value	8,003	2,259
Hones, oilstones, and whetstones	10,636	6,075
Ichthyol	36,232	39,452
Lead paints, litharge, orange mineral, red lead, white lead	6,870	215
Lime	70,505	73,458
Magnesia	17,761	508
Magnesite	464,706	927,255
Marble and stone (exclusive of granite)	646,433	257,596
Mica	1,430,048	1,511,129
Mineral waters	268,665	241,641
Mineral salts, by evaporation from mineral waters	4,858	10,231
Monazite sand and thorium oxide	355,017	204,661
Ocher	234,490	193,647
Peat	4,966	....
Petroleum:		
Crude	16,400,017	21,319,464
Benzine, gasoline, and naphtha	1,411,453	1,921,895
Ozokerite	90,510	147,806
Paraffin oil	3,514	3,988
Paraffin wax	638,700	546,342
All other	2,793,701	2,428,436
Pumice stone	147,278	33,014
Pyrite	5,981,457	2,741,676
Salt	280,135	281,468
Sand	142,586	91,465
Selenium	2,236	....
Sienna and sienna earths	57,330	60,154
Slate	1,024	321
Strontium	23,216	2,459
Sulphur or brimstone	29,340	9,542
Talc	269,497	260,576
Thorium nitrate	2,359	....
Umber	42,620	13,859
Venetian red	5,967	3,653
Zirconium ore	(a)	b77,250
	163,685,630	189,752,508
Exports.		
Abrasives:		
Wheels, emery and other	4,481,600	3,862,531
All other (exclusive of grindstones)	1,941,512	1,982,822
Asbestos:		
Ore and unmanufactured	116,580	51,053
Manufactured	1,932,551	2,493,325
Asphalt:		
Unmanufactured	587,256	577,654
Manufactured	585,472	577,936
Cement	5,328,536	5,912,166
Clay:		
Fire	268,093	333,880
All other	178,764	192,053
Coal:		
Anthracite	30,909,708	29,215,089
Bituminous	c79,502,654	c78,664,856
Coke	8,543,746	11,861,408
Earthen, stone, and china ware:		
Bricks—		
Building	196,207	117,263
Fire	4,011,546	5,001,057
Chinaware	422,641	318,448
Earthen and stone ware	805,784	783,577
Sanitary earthenware	323,558	377,527
Tiles, except drain	450,422	582,051
All other	743,105	752,651
Fertilizers:		
Phosphate rock, ground or unground—		
High-grade hard rock	113,392	445,419
Land pebble	548,203	303,758
All other	173,450	163,308
Graphite:		
Unmanufactured	349,563	121,555
Manufactured	891,687	731,518
Lime	168,671	105,803
Mica:		
Unmanufactured Manufactured	74,485	74,529

[a] Not separately classified.

[b] Figures cover period July to December. Not separately classified prior to July 1.

[c] Does not include bunker coal laden as fuel on vessels in the foreign trade, which aggregated $31,844,799 in 1917 and $29,868,023 in 1918.

Value of imports for consumption and of exports of mineral products in the calendar years 1917 and 1918—Continued.

	1917	1918
NONMETALLIC PRODUCTS—continued.		
Exports—Continued.		
Paints:		
Red lead	[a] $267,238	$662,584
White lead	2,089,659	1,756,739
Zinc oxide	3,148,898	2,779,597
Petroleum:		
Crude	7,668,312	12,084,250
Gasoline	49,049,647	85,225,574
Naphtha	44,084,597	54,368,166
Illuminating	48,953,610	50,354,414
Fuel oil and gas oil	[b] 45,549,282	[b] 66,615,743
Lubricating and heavy paraffin	[c] 26,108,011	....
Paraffin	[a] 1,192,297	1,454,327
All other	[a] 30,264,556	74,148,728
Jelly, etc	1,246,901	1,635,590
Paraffin wax	17,906,706	22,273,612
Residuum	107,164	14,298
Plaster, builders' and common	159,875	174,481
Wall board (suitable for plaster)	106,118	421,985
Potash:		
Chlorate	[a] 475,434	534,491
All other potassium	[a] 638,768	837,679
Salt	1,000,773	1,677,577
Sand and gravel	494,251	619,414
Soda	[c] 9,322,233	....
Caustic	[a] 5,832,598	5,602,813
Sal soda	[a] 97,772	213,865
Silicate	[a] 216,828	404,796
Soda ash	[a] 2,884,569	7,805,550
Other salts of soda	[a] 4,030,196	6,587,134
Stone, including marble:		
Unmanufactured	572,097	552,261
Manufactures of:		
Grindstones	198,772	210,889
Roofing slate	27,113	65,224
All other	1,108,185	1,208,164
Sulphur or brimstone	3,500,819	3,626,638
	451,952,555	549,520,330

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[a] Classification changed July 1. Figures cover period July to December.

[b] Does not include bunker oil laden as fuel on vessels in the foreign trade, which aggregated $7,391,985 in 1917 and $11,676,053 in 1918.

[c] Figures cover period January to June. Classification changed July 1.

DETAILED TABLES.

ABRASIVE MATERIALS.

PRODUCTION.

Natural abrasives marketed by producers in the United States, 1913–1918.

Abrasive.	1913		1914		1915	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Millstones	(a)	$56,163	(a)	$43,316	(a)	$53,480
Grindstones and pulpstones	(a)	855,627	[b] 48,272	689,344	[b] 42,623	648,479
Oilstones and scythestones	(a)	207,352	(a)	167,948	(a)	115,175
Emery and corundum	[c] 957	[c] 4,785	[c] 485	[c] 2,425	[c] 3,063	[c] 31,131
Garnet	5,308	183,422	4,231	145,510	4,301	139,584
Abrasive quartz and feldspar	(d)	(d)	(d)	(d)	(d)	(d)
Diatomaceous (infusorial) earth and tripoli [e]	27,383	285,821	28,230	252,327	35,304	167,474
Pumice	24,563	55,408	27,591	59,172	27,708	63,185
Grinding pebbles	....	....	....	....	....	....
Tube-mill lining	....	....	....	....	....	....
	....	1,648,578	....	1,360,042	....	1,218,508

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[a] Figures not available, as product was not reported by weight.

[b] Quantity represents grindstones only, as pulpstones were not reported by weight.

[c] Emery only. No corundum produced.

[d] See sections on feldspar and silica (quartz).

[e] Includes rottenstone, but excludes from 1915 to 1918, inclusive, considerable production of diatomaceous earth for special uses upon which the Survey is not at liberty to report.

Natural abrasives marketed by producers in the United States, 1913–1918—Continued.

Abrasive.	1916		1917		1918	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Millstones	(a)	$44,559	(a)	$43,489	(a)	$92,514
Grindstones and pulpstones	[b] 50,839	766,140	[b] 54,432	1,147,784	65,339	1,776,282
Oilstones and scythestones	(a)	154,573	1,816	168,704	1,010	189,033
Emery and corundum	[c] 15,282	[c] 123,901	17,135	241,050	10,422	112,878
Garnet	6,171	208,850	4,995	198,327	4,696	248,161
Abrasive quartz and feldspar	(d)	(d)	(d)	(d)	(d)	(d)
Diatomaceous (infusorial) earth and tripoli [e]	45,978	241,553	29,102	369,556	22,947	224,801
Pumice	33,320	82,263	35,293	84,814	30,637	91,178
Grinding pebbles	(a)	42,500	12,000	72,191	9,934	82,851
Tube-mill lining	....	....	3,050	59,250	2,535	46,634
	....	1,664,339	....	2,385,165	....	2,864,332

[a] Figures not available, as product was not reported by weight.

[b] Quantity represents grindstones only, as pulpstones were not reported by weight.

[c] Emery only. No corundum produced.

[d] See sections on feldspar and silica (quartz).

[e] Includes rottenstone, but excludes from 1915 to 1918, inclusive, considerable production of diatomaceous earth for special uses upon which the Survey is not at liberty to report.

IMPORTS.

Value of abrasive materials imported for consumption in the United States, 1914-1918.

Material.	1914	1915	1916	1917	1918
Millstones and burrstones	$15,000	$17,027	$19,816	$18,227	$20,017
Grindstones and pulpstones	109,539	68,892	63,277	57,950	27,361
Hones, oilstones, and whetstones	33,655	14,247	10,614	10,636	6,075
Emery and corundum	383,436	271,649	240,737	210,602	614,167
Diatomaceous earth, tripoli, and rottenstone	20,004	27,333	37,573	17,864	11,128
Pumice	92,668	65,691	116,543	147,278	33,014
Diamond dust and bort	74,408	75,944	67,290	349,746	475,870
	728,710	540,783	555,850	812,303	1,187,632

EXPORTS.

Value of domestic abrasive materials exported, 1913-1918.

Material.	1913	1914	1915	1916	1917	1918
Grindstones	$168,803	$108,040	$128,879	$176,563	$198,772	$210,889
Abrasive wheels, emery, and other	731,297	572,218	1,200,421	2,240,227	4,481,600	3,862,531
All other	1,551,892	1,123,508	1,403,796	2,035,951	1,941,512	1,982,822

ALUMINUM.

[See under Bauxite and aluminum.]

ANTIMONY AND ANTIMONIAL LEAD.

PRODUCTION.

Mine production of antimony ores in the United States, 1915-1918.

Year.	Quantity (short tons).	Antimony content (short tons).
1915 [a]	5,000	2,100
1916	4,500	1,770
1917	1,060	390
1918	190	50

[a] Mine production negligible prior to 1915.

Smelter production of metallic antimony in the United States, 1917 and 1918.

Year.	From domestic ores.		From foreign ores.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1917 [a]	258	$106,812	2,182	$903,348	2,440	$1,010,160
1918	127	32,004	2,490	627,480	2,617	659,484

[a] Not recorded prior to 1917.

Antimony content of secondary alloys recovered from old alloys, scrap, and dross, 1913–1918.

Year.	Quantity (short tons).	Value.[a]	Year.	Quantity (short tons).	Value.[a]
1913	2,705	$401,963	1916	4,480	$2,270,016
1914	2,646	444,844	1917	4,961	2,061,700
1915	3,102	1,811,568	1918	5,226	1,317,000

[a] Values calculated at average yearly price for ordinary brands of antimony as published by the American Metal Market.

By-product antimonial lead produced in the United States from both foreign and domestic ores, 1913–1918.

Year.	Quantity (short tons).	Value.	Antimony content (short tons).	Year.	Quantity (short tons).	Value.	Antimony content (short tons).
1913	16,665	$1,591,854	2,508	1916	24,038	$4,483,582	3,496
1914	16,667	1,572,167	2,693	1917	18,646	3,781,560	2,759
1915	23,224	3,665,736	3,425	1918	18,570	2,826,350	2,566

IMPORTS.

Antimony imported and entered for consumption, 1913–1918.

Year.	Antimony ore.[a]			Liquated antimony sulphide.[b]		Metallic antimony.[c]		Antimony oxide and other compounds.[d]	
	Quantity (short tons).	Antimony content (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	2,860	2,007	$137,361	3	$419	6,240	$798,581	984	$117,169
1914	1,791	1,254	71,341	49	4,004	6,555	736,420	1,372	315,001
1915	2,494	1,544	332,125	....	....	7,354	2,660,830	423	132,193
1916	7,840	4,622	1,072,340	....	....	7,064	3,548,507	243	109,832
1917	10,083	5,832	1,006,884	796	128,660	11,286	2,829,159	10	5,368
1918	3,363	1,425	177,731	833	113,258	14,011	3,065,619	18	11,904

[a] Classified in tariff classification as "Antimony ores and stibnite containing antimony."
[b] Classified in tariff classification as "Antimony matte, containing not more than 10 per cent of lead."
[c] Classified in tariff classification as "Antimony regulus or metal."
[d] Classified in tariff classification as "Antimony, oxide, salts, and compounds of."

Total imports[a] of antimony into the United States in 1917 and 1918.

1917.

Country.	Antimony ore.			Antimony metal.[b]	
	Quantity (short tons).	Antimony content.		Quantity (pounds).	Value.
		Quantity (pounds).	Value.		
Canada	126	105,077	$15,762	190,000	$24,879
Newfoundland and Labrador	22	30,136	1,985	....	....
Mexico	2,116	1,434,403	76,712	4,126,659	416,866
Argentina[c]	596	632,662	55,514	....	....
Chile[c]	4,098	5,131,569	507,463	....	....
Peru	44	27,570	3,636	....	....
Colombia	2	2,356	255	....	....
Honduras	3	4,785	1,563	....	....
China	2,949	4,060,353	331,504	11,324,846	1,333,541
Hongkong[d]	....	....	....	859,835	101,568
Japan[d]	....	....	....	18,677,597	2,333,745
England	....	....	....	470,176	87,081
Portugal	302	390,282	27,870	....	....
Portuguese Africa[e]	112	101,250	9,734	....	....
	10,370	11,920,443	1,031,998	35,649,113	4,297,680

1918.

Country.	Antimony ore.			Antimony metal.[b]	
	Quantity (short tons).	Antimony content.		Quantity (pounds).	Value.
		Quantity (pounds).	Value.		
Canada	....	....	....	231,990	$22,856
Panama	1	711	$128	....	....
Mexico	1,623	1,203,257	80,540	5,958,689	560,872
Chile[c]	987	1,343,700	84,890	....	....
Peru	11	14,594	1,100	....	....
China	112	156,800	9,480	14,271,511	1,354,360
Hongkong[d]	....	....	....	1,064,224	109,532
Japan[d]	....	....	....	6,221,904	616,643
	2,734	2,719,062	176,138	27,748,318	2,664,263

[a] Includes large quantities of antimony metal that went into bonded warehouse and that are not included in the table of imports for consumption.

[b] Includes small quantities of liquated antimony sulphide, known in the trade as "crude antimony," "antimony matte," and "needle antimony."

[c] Imports credited to Chile originated mainly in Bolivia; those credited to Argentina may also be Bolivian.

[d] Nearly all the imports of antimony ore and metal from Hongkong and Japan are of Chinese origin Some of the material credited to other countries is possibly also of Chinese origin, having been transshipped. in a foreign port.

[e] Probably of Transvaal origin.

EXPORTS.

Exports of foreign antimony from the United States, 1914–1918.[a]

Year.	Ore.			Matte, regulus, or metal.	
	Quantity (short tons).	Antimony content (pounds).	Value.	Quantity (pounds).	Value.
1914				1,600,979	$211,742
1915		195	$8	3,146,135	786,766
1916	231	255,695	9,874	3,018,251	761,045
1917				989,477	169,260
1918				1,410,970	164,666

[a] Exports go mainly to Canada.

PRICES.

The average New York prices for the highest grades of metallic antimony for the last 24 years, in cents per pound, are given by the Engineering and Mining Journal as follows:

1895	7.56	1903	6.00	1911	7.54
1896	6.65	1904	6.37	1912	7.76
1897	6.75	1905	10.25	1913	7.52
1898	8.69	1906	21.73	1914	8.76
1899	9.43	1907	14.84	1915	30.28
1900	9.50	1908	8.00	1916	25.37
1901	8.25	1909	7.47	1917	20.69
1902	6.12	1910	7.39	1918	12.58

ARSENIC.

PRODUCTION.

White arsenic (As_2O_3) produced in the United States, 1909–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1909	1,214	$52,946	1914	[a] 4,670	$313,147
1910	1,497	52,305	1915	[b] 5,498	302,116
1911	3,132	73,408	1916	[c] 5,986	555,187
1912	3,141	190,757	1917	6,151	1,118,313
1913	2,513	159,236	1918	[d] 6,323	1,213,000

[a] This quantity includes 200 tons of crude arsenic trioxide carrying about 97.5 per cent As_2O_3.
[b] This quantity includes 353 tons of crude arsenic trioxide carrying about 97.5 per cent As_2O_3.
[c] This quantity includes 152 tons of crude arsenic trioxide carrying about 97.5 per cent As_2O_3.
[d] In addition to the arsenious oxide (or white arsenic), metallic arsenic was produced in 1918.

IMPORTS.

Arsenic compounds imported and entered for consumption in the United States, 1913–1918.

Year.	Arsenic or arsenious acid (white arsenic, As_2O_3).		Arsenic and sulphide of, or orpiment.		Sheep dip.		Paris green and London purple.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1913	1,519	$133,597	3,182	$276,849		$40,036	99,692	$4,431
1914	1,594	109,121	2,034	164,592		34,556	15,476	2,235
1915	1,400	113,677	1,783	154,099		19,916	21,056	4,069
1916	1,071	107,876	1,092	124,818		20,134	23,461	5,028
1917	1,178	264,534	2,777	410,341		15,848	48	189
1918	1,847	441,212	4,842	840,600		23,538		

EXPORTS.[a]

Foreign exports of arsenic and sulphide of, or orpiment, 1913–1918.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1913	60,000	$3,135	1916	1,761	$1,256
1914	700	79	1917	118,600	15,840
1915	9,776	526	1918	80,050	12,017

[a] There are no domestic exports.

ASBESTOS.

SUPPLY.

Supplies of asbestos in the United States, 1913–1918.

Year.	Production (sales).		Imports (unmanufactured).[a]		Exports (unmanufactured).		Apparent consumption.[b]	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	1,100	$11,000	97,145	$1,928,705	(c)	(c)	(c)	(c)
1914	1,247	18,965	71,866	1,407,758	(c)	(c)	(c)	(c)
1915	1,731	76,952	93,566	1,981,483	(c)	(c)	(c)	(c)
1916	1,479	448,214	116,162	3,303,470	[d] 312	[d] $6,133	(c)	(c)
1917	1,683	506,056	134,108	4,521,172	708	116,580	135,083	$4,910,648
1918	1,002	124,687	137,700	6,337,585	697	51,053	138,005	6,411,219

[a] Mainly from Canada.

[b] Production plus imports minus exports.

[c] Exports not separately recorded prior to July, 1916

[d] Figures cover period July to December, 1916.

ASPHALT AND RELATED BITUMENS.

PRODUCTION.

Asphalt produced in the United States from domestic petroleum, 1904–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1904	44,405	$459,135	1909	129,594	$1,565,427	1914	360,683	$3,016,969
1905	52,369	452,911	1910	161,187	2,225,833	1915	664,503	4,715,583
1906	64,997	615,406	1911	277,192	3,173,859	1916	688,334	6,178,851
1907	137,948	1,898,108	1912	354,344	3,755,506	1917	701,809	7,734,691
1908	119,817	1,540,396	1913	436,586	4,531,657	1918	527,575	7,435,204

Asphalt produced in the United States from Mexican petroleum, 1913–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1913	114,437	$1,743,749	1916	572,387	$6,018,851
1914	313,787	4,131,153	1917	645,613	7,441,818
1915	388,318	3,730,436	1918	650,244	10,324,020

Native asphalt and related bitumens produced in the United States, 1904–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1904	64,167	$420,701	1909	99,061	$572,846	1914	79,888	$642,123
1905	62,898	305,242	1910	98,893	854,234	1915	75,751	526,490
1906	73,062	674,931	1911	87,074	817,250	1916	98,477	923,281
1907	85,913	928,381	1912	96,166	865,225	1917	81,604	773,424
1908	78,565	517,485	1913	92,604	750,713	1918	60,034	780,808

IMPORTS.

Asphalt and related bitumens imported for consumption in the United States, 1913–1918.

Year.	Crude asphalt.		Dried or advanced asphalt.		Ozokerite.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	[a] 207,033	$738,452	[a] 14,750	$133,336	3,571	$549,992
1914	137,352	664,558			4,096	498,695
1915	135,276	661,356			1,398	210,019
1916	147,383	732,917			1,504	196,185
1917	187,473	978,087			450	90,510
1918	114,686	624,967			905	147,805

Year.	Ichthyol.		Bituminous limestone.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	29	$83,034	6,395	$38,823	231,778	$1,543,637
1914	31	86,415	1,705	11,060	143,184	1,260,728
1915	12	28,560	2,976	19,001	139,662	918,936
1916	58	93,762	330	1,795	149,275	1,024,659
1917	29	36,232	413	15,028	188,365	1,119,857
1918	33	39,452	39	2,528	115,663	814,752

[a] Last three months of 1913, dried or advanced asphalt included in figures for crude asphalt.

EXPORTS.

Asphalt exported from the United States, 1913–1918.

Year.	Unmanufactured.		Manufactures of (value).	Total value.
	Quantity (short tons).	Value.		
1913	65,576	$1,267,625	$411,786	$1,679,411
1914	41,716	845,838	401,182	1,247,020
1915	42,787	735,952	438,685	1,174,637
1916	40,816	759,769	494,895	1,254,664
1917	30,107	587,256	585,472	1,172,728
1918	22,108	577,654	577,936	1,155,590

BARYTES.

SUPPLY.

Supplies of crude barytes in the United States, 1913–1918.

Year.	Domestic barytes produced.		Barytes imported for consumption.		Apparent consumption.[a]	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	45,298	$156,275	35,840	$61,409	81,138	$217,684
1914	52,747	155,647	24,423	46,782	77,170	202,429
1915	108,547	381,032	2,504	4,877	111,051	385,909
1916	221,952	1,011,232	17	245	221,969	1,011,477
1917	206,888	1,171,184	6	63	206,894	1,171,247
1918	155,368	1,044,905			155,368	1,044,906

[a] No exports reported. Stocks at plants included, but those at mines excluded.

PRODUCTION.

Crude barytes produced and marketed in the United States, 1917 and 1918, by States.

State.	1917			1918		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
Alabama	1,976	$8,868	$4.49	1,794	$9,976	$5.56
Georgia	111,300	601,895	5.41	69,318	418,178	6.03
Kentucky	6,720	36,084	5.37	(a)	(a)	(a)
Missouri	59,046	391,363	6.63	49,094	393,738	8.02
North Carolina	1,019	5,080	4.99	(a)	(a)	(a)
Tennessee	16,972	79,058	4.66	22,542	141,844	6.29
Other States [b]	9,855	48,836	4.96	12,620	81,169	6.43
	206,888	1,171,184	5.66	155,368	1,044,905	6.73

[a] Included in "Other States."

[b] 1917: California, Nevada, South Carolina, and Virginia; 1918: Kentucky, Nevada, New Mexico, North Carolina, South Carolina, Virginia, and Wisconsin.

BAUXITE AND ALUMINUM.

BAUXITE.

SUPPLY.

Bauxite supplies in the United States, 1913–1918.

Year.	Domestic production.					
	Georgia, Alabama, and Tennessee.		Arkansas.		Total.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1913	40,370	$150,710	169,871	$846,988	210,241	$997,698
1914	24,071	92,508	195,247	976,686	219,318	1,069,194
1915	28,245	144,345	268,796	1,370,489	297,041	1,514,834
1916	49,190	284,810	375,910	2,011,590	425,100	2,296,400
1917	62,134	395,051	506,556	2,724,007	568,690	3,119,058
1918	42,829	314,112	562,892	3,133,880	605,721	3,447,992

Bauxite supplies in the United States, 1913–1918—Continued.

Year.	Imports.		Exports.[a]		Domestic consumption.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1913	21,456	$85,746	(b)	(b)	231,697	$1,083,444
1914	24,844	96,500	[c] 5,374	$240,084	238,788	925,610
1915	3,420	17,107	16,082	717,186	284,379	814,755
1916	30	87	17,939	987,454	407,191	1,309,033
1917	7,691	28,989	21,791	1,323,926	554,590	1,824,121
1918	3,653	14,791	19,711	1,523,688	589,663	1,939,095

[a] Includes bauxite concentrates. [b] Not separately reported. [c] From July 1, 1914.

WORLD'S PRODUCTION.

World's production of bauxite, 1913–1917.

Country.	1913		1914		1915	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
United States	210,241	$997,698	219,318	$1,069,194	297,041	$1,514,834
France	304,407	(a)	(a)	(a)	(a)	(a)
United Kingdom	6,055	7,606	8,286	10,507	11,723	15,393
Italy	6,843	16,101	3,844	9,046	6,504	15,942
India	1,184	161	514	156	(a)	141

Country.	1916		1917	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
United States	425,100	$2,296,400	568,690	$3,119,058
France	(a)	(a)	(a)	(a)
United Kingdom	10,329	14,477	14,724	20,106
Italy	8,746	(a)	7,666	67,647
India	750	2,253	1,363	3,017

[a] Statistics not available.

ALUMINUM.

PRODUCTION.

Value of aluminum produced in the United States, 1913–1918.

Year.	Primary metal.	Secondary metal.[a]	Year.	Primary metal.	Secondary metal.[a]
1913	$9,450,000	$2,199,480	1916	$33,900,000	$23,430,200
1914	10,080,000	1,673,140	1917	45,882,000	16,711,800
1915	16,280,000	5,802,100	1918	41,159,000	10,113,600

[a] Value based on average open-market price, as quoted by the Engineering and Mining Journal.

IMPORTS.

Aluminum imported for consumption in the United States, 1913–1918.

Year.	Crude and semicrude.[a]		Manufactures of.[b]	Total value.
	Quantity (pounds).	Value.		
1913	25,095,441	$4,388,283	$396,019	$4,784,302
1914	17,942,958	3,353,983	720,650	4,074,583
1915	9,293,574	1,765,967	75,812	1,841,779
1916	6,698,615	1,752,918	32,952	1,785,870
1917	89,291	35,386	21,504	56,890
1918	1,690,683	533,704	20,882	554,586

[a] Includes crude aluminum, plates, sheets, and wire.
[b] Includes aluminum leaf, kitchen utensils, and all other manufactures of aluminum.

EXPORTS.

Aluminum and manufactures of aluminum exported, 1913–1918.

Year.	Crude and semicrude.[a]		Manufactures.	Total value.
	Quantity (pounds).	Value.		
1913			$966,094	$21,611,855
1914			1,546,510	
1915			3,682,117	
1916			15,417,134	
1917 Jan.–June			9,029,458	14,586,467
1917 July–Dec.	10,020,404	$4,571,193	985,816	
1918	24,135,234	8,979,052	1,890,336	10,869,388

[a] Includes ingots, metal and alloys, plates and sheets.

PRICES.

Prices of aluminum, 1913–1918, in cents per pound.[a]

Year.	Average open market price, small lots.	Contract price.	Year.	Average open market price, small lots.	Contract price.
1913	23.64	(b)	1916	60.71	31–37
1914	18.63	(b)	1917	51.59	31–37
1915	33.98	20–31	1918	33.42	(c)

[a] Engineering and Mining Journal quotations in annual review numbers.
[b] No figures published, but it seems reasonable to believe that contracts were made on approximately the same basis as for 1912, namely, 20 to 21 cents a pound.
[c] Figures not available.

BISMUTH.

PRODUCTION.

There was only one producer of bismuth in this country in 1918. The output was small, being less than half of that for 1917. The bismuth produced in this country is almost entirely a by-product obtained in the refining of lead bullion.

IMPORTS.

Bismuth imported for consumption in the United States, 1912–1918.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1913	117,747	$213,257	1916	76,723	$195,975
1914	90,505	165,208	1917	69,250	142,300
1915	44,362	108,288	1918	135,700	277,273

EXPORTS.

No exports of bismuth are recorded.

BORAX.

[See under Sodium and sodium compounds.]

BRIQUETS (FUEL).

PRODUCTION.

Fuel briquets produced in the United States in 1908–1909 and 1911–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1908	90,358	$323,057	1914	250,635	$1,154,678
1909	139,661	452,697	1915	221,537	1,035,716
1911	218,443	808,721	1916	295,155	1,445,662
1912	220,064	952,261	1917	406,856	2,233,888
1913	181,859	1,007,327	1918	477,235	3,212,793

Raw fuels used in making briquets in 1917 and 1918, in short tons.

Fuel.	1917	1918	Fuel.	1917	1918
Anthracite culm and fine sizes	137,659	209,690	Lignite and subbituminous coal.	103,408	76,602
Semianthracite	161,269	180,714	Oil-gas residue		
Semibituminous					
Bituminous slack				402,336	467,006

IMPORTS.

Imports for consumption, 1913–1918, of composition used for fuel in which coal or coal dust is the component material of chief value, whether in briquets or other form.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1913		$2,455	1917		
1914		209	1918	(a) b 432	a $280 b 2,797
1915		46			
1916		75			

a Figures cover 6 months, January to June. Quantity not shown prior to July.
b Figures cover 6 months, July to December.

BROMINE.

PRODUCTION.

Bromine produced and marketed in the United States, 1913–1918.

Year.	Quantity (pounds).	Value.	Average price per pound.	Year.	Quantity (pounds).	Value.	Average price per pound.
1913..........	572,400	$115,436	$0.20	1916..........	728,520	$951,932	$1.31
1914..........	576,991	203,094	.35	1917..........	895,499	492,708	.55
1915..........	855,857	856,307	1.00	1918..........	1,727,156	970,099	.56

IMPORTS AND EXPORTS.

Imports and exports are not specifically shown.

CADMIUM.

PRODUCTION.

Metallic cadmium and cadmium sulphide produced in the United States, 1913–1918.

Year.	Metallic cadmium.			Cadmium sulphide.		
	Quantity (pounds).	Value.	Average price per pound.	Quantity (pounds).	Value.	Average price per pound.
1913..........................	54,198	$41,838	$0.77	17,302	$12,136	$0.70
1914..........................	[a]91,400	81,205	.89	22,723	20,241	.88
1915..........................	91,415	108,443	1.19	10,624	12,057	1.13
1916..........................	135,212	210,931	1.56	22,176	27,942	1.26
1917..........................	207,408	305,097	1.47	50,169	70,939	1.41
1918..........................	127,164	188,203	1.48	51,702	70,315	1.36

[a] Exclusive of 4,225 pounds of cadmium in residues sold for export.

IMPORTS.

Cadmium imported and entered for consumption in the United States, 1909–1918.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1909 first half............	[a]6,659	$4,559	1914......................	441	$368
1909 second half..........	2,203		1915......................	269	284
1910......................	4,060	2,295	1916......................	....	....
1911......................	5,367	3,870	1917......................	....	....
1912......................	5,250	3,764	1918......................	....	....
1913	1,656	1,232			

[a] The records of the Bureau of Foreign and Domestic Commerce do not show quantity prior to July, 1909. This figure has been computed by dividing the value of the imports by the average price of cadmium in Germany, from which country the cadmium was imported.

EXPORTS.

Cadmium licensed for export, Feb. 1, 1918–Jan. 31, 1919.[a]

Destination.	Quantity (pounds).	Value.	Destination.	Quantity (pounds).	Value.
Canada..................	3,025	$4,094	Norway..................	6,740	$8,094
France..................	30,440	47,960			
Great Britain............	2,005	2,612		42,320	63,020
Italy.....................	110	260			

[a] From records of War Trade Board.

CALCIUM CHLORIDE.

PRODUCTION.

Calcium-magnesium chloride produced and marketed in the United States, 1913–1918.

Year.	Quantity (short tons).	Value.	Average price per ton.	Year.	Quantity (short tons).	Value.	Average price per ton.
1913	19,611	$130,030	$6.63	1916	27,709	$224,997	$8.12
1914	19,403	121,766	6.28	1917	30,503	451,480	14.80
1915	20,535	130,830	6.37	1918	26,624	503,452	18.90

IMPORTS AND EXPORTS.

Imports and exports are not specifically shown.

CEMENT.

SUPPLY.

Supplies of Portland cement in the United States, 1913–1918.

Year.	Domestic shipments.		Imports.[a]		Exports.[b]		Apparent consumption.[c]	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1913	88,689,377	$89,106,975	85,470	$139,416	2,964,358	$4,270,666	85,810,489	$84,975,725
1914	86,437,956	80,118,475	120,906	194,053	2,140,197	3,088,809	84,418,665	77,223,719
1915	86,891,681	74,756,674	42,218	57,174	2,565,031	3,361,451	84,368,868	71,452,397
1916	94,552,296	104,258,216	1,836	4,942	2,563,976	3,828,231	91,990,156	100,434,927
1917	90,703,474	122,775,088	2,323	6,076	2,586,215	5,328,536	88,119,582	117,452,628
1918	70,915,508	113,153,513	305	1,200	2,252,446	5,912,166	68,663,367	107,242,547

[a] Imports of all classes of hydraulic cement for consumption.
[b] Mostly Portland cement.
[c] Domestic shipments plus imports minus exports.

PRODUCTION.

Principal hydraulic cements produced in the United States, 1913–1918.

Year.	Natural cement.		Portland cement.	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1913	744,658	$345,889	92,097,131	$92,557,617
1914	751,285	351,370	88,230,170	81,789,368
1915	750,863	358,627	85,914,907	73,886,820
1916	[a] 842,137	[a] 430,874	91,521,198	100,947,881
1917	[a] 639,456	[a] 435,370	92,814,202	125,670,430
1918	[a] 432,966	[a] 401,341	71,081,663	113,446,334

Year.	Puzzolan cement.		Total.	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1913	107,313	$97,663	92,949,102	$93,001,169
1914	68,311	63,358	89,049,766	82,204,096
1915	42,678	39,801	86,708,448	74,285,248
1916	(a)	(a)	92,363,335	101,378,755
1917	(a)	(a)	93,453,658	126,105,800
1918	(a)	(a)	71,514,629	113,847,675

[a] Figures for puzzolan included with natural cement.

Portland cement shipped and produced in 1917 and 1918, by States.

[Figures opposite S relate to shipments; those opposite P to production.]

State.		Active plants.		1917		1918		Percentage of change in quantity, 1918.	Average factory price per barrel.	
		1917	1918	Quantity (barrels).	Value.	Quantity (barrels).	Value.		1917	1918
California	S	9	10	5,659,547	$7,426,097	4,238,424	$7,091,789	−25.1	$1.312	$1.673
	P	9	9	5,653,362		4,354,074				
Illinois	S	4	4	4,378,233	6,090,158	3,703,471	5,695,186	−15.4	1.391	1.538
	P	4	4	4,659,990		3,594,038				
Indiana	S	5	5	8,148,678	11,084,930	6,205,326	9,580,563	−23.8	1.360	1.544
	P	5	5	8,705,831		5,291,851				
Iowa	S	4	4	4,428,765	6,870,863	3,188,669	5,423,926	−28.0	1.551	1.701
	P	4	4	4,626,141		3,626,455				
Kansas	S	8	7	3,772,884	5,271,721	2,586,834	4,219,203	−31.4	1.397	1.631
	P	8	7	4,015,169		2,499,723				
Michigan	S	11	10	4,313,771	6,122,887	3,618,088	6,078,167	−16.1	1.419	1.680
	P	11	10	4,688,899		3,554,872				
Missouri	S	5	5	5,800,988	8,248,007	4,515,695	7,132,470	−22.2	1.422	1.579
	P	5	5	5,882,240		4,738,596				
New Jersey	S	3	2	2,397,069	2,962,592	(a)	(a)	(a)	1.236	(a)
	P	2	2	2,449,876		(a)				
New York	S	9	8	5,408,726	7,050,656	4,074,159	6,568,746	−24.7	1.304	1.612
	P	9	8	5,417,530		4,095,588				
Ohio	S	5	5	1,565,394	2,328,432	1,289,887	2,208,119	−17.6	1.487	1.712
	P	5	5	1,566,209		1,440,859				
Oklahoma	S	3	3	1,736,761	2,633,479	1,218,841	2,203,041	−29.8	1.516	1.807
	P	3	3	1,772,466		1,246,515				
Pennsylvania	S	21	21	27,709,442	34,512,388	22,238,689	33,600,956	−19.7	1.246	1.511
	P	21	21	27,752,838		22,628,901				
Texas	S	5	5	2,358,944	3,661,328	1,918,919	3,297,977	−18.7	1.552	1.719
	P	5	5	2,436,398		1,971,867				
Utah	S	3	3	899,599	1,461,689	549,593	923,155	−38.9	1.625	1.680
	P	3	3	929,730		570,310				
Washington	S	5	5	1,403,191	2,367,045	1,116,754	2,114,730	−20.4	1.687	1.894
	P	5	5	1,513,792		931,489				
Other States [b]	S	18	18	10,721,482	14,682,816	10,452,159	17,015,485	−20.3	1.369	1.628
	P	18	18	10,743,731		10,536,525				
	S	118	115	90,703,474	122,775,088	70,915,508	113,153,513	−21.8	1.354	1.596
	P	117	114	92,814,202		71,081,663				

[a] Included in "Other States."

[b] 1917: Alabama, Colorado, Georgia, Kentucky, Maryland, Minnesota, Montana, Nebraska, Oregon, Tennessee, Virginia, and West Virginia; 1918: same States as in 1917, with New Jersey included and Nebraska excluded.

PRICES.

The average factory price of Portland cement per barrel in bulk in 1918 was $1.596, compared with $1.354 in 1917. These are the highest prices for Portland cement that have been realized since 1898 and 1899, when the prices were, respectively, $1.62 and $1.43. The lowest average price, $0.813, was recorded in 1912 and 1909.

CHROMITE.

SUPPLY.

Supplies of chromite in the United States, 1913–1918.

Year.	Domestic shipments (long tons).	Value.	Imports [a] (long tons).	Value.	Apparent consumption [b] (long tons).	Value.
1913	255	$2,854	65,180	$622,821	65,435	$625,675
1914	591	8,715	80,736	695,645	81,327	704,360
1915	3,281	36,744	76,455	780,061	79,736	816,805
1916	47,035	726,243	115,945	1,548,402	162,980	2,274,645
1917	43,725	1,049,400	72,063	1,110,659	115,788	2,160,059
1918	82,430	3,955,567	100,142	2,892,825	182,572	6,848,392

[a] Imports for consumption.

[b] There are no exports of chromite.

CLAY.

PRODUCTION.

Clay marketed in the United States, 1913–1918.

Year.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	28, 834	$235, 457	126, 377	$567, 977	10, 902	$24, 505	67, 134	$237, 672	1, 820, 379	$2, 592, 591
1914	34, 191	284, 817	116, 328	558, 334	8, 237	17, 731	67, 927	255, 767	1, 409, 467	2, 147, 277
1915	28, 031	241, 520	113, 033	539, 622	7, 646	18, 774	75, 348	301, 910	1, 570, 481	2, 361, 482
1916	47, 723	306, 819	153, 434	768, 911	14, 064	47, 939	89, 761	391, 152	2, 057, 814	3, 708, 009
1917	31, 885	301, 378	174, 449	962, 421	16, 972	70, 505	107, 406	569, 240	2, 347, 972	5, 625, 095
1918	37, 969	391, 109	141, 725	1,068,420	13, 552	49, 898	89, 896	590, 631	2, 306, 033	5, 664, 064

Year.	Stoneware clay.		Brick clay.		Miscellaneous clay.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	153, 353	$143, 587	158, 890	$137, 976	282, 120	$240, 694	2, 647, 989	$4, 180, 459
1914	130, 383	116, 610	199, 154	161, 852	244, 173	214, 180	2, 209, 860	3, 756, 568
1915	134, 297	126, 429	101, 968	93, 863	332, 150	288, 341	2, 362, 954	3, 971, 941
1916	135, 958	137, 779	97, 164	76, 854	336, 672	314, 311	2, 932, 590	5, 751, 774
1917	81, 352	113, 839	93, 779	94, 703	280, 029	305, 365	3, 113, 844	8, 042, 546
1918	86, 800	147, 098	(a)	(a)	301, 386	421, 421	2, 976, 361	8, 332, 641

a Included under "Miscellaneous clay."

IMPORTS.

Clay imported and entered for consumption in the United States, 1913–1918.

Year.	Kaolin or china clay.			Common blue and Gross-Almerode glass-pot clay.		All other clays.				Total.	
						Unwrought.		Wrought.			
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	268, 666	$1, 623, 993	$6. 04	24, 986	$204, 911	42, 582	$155, 693	1, 889	$22, 178	338, 123	$2, 006, 775
1914	328, 038	1, 927, 425	5. 88	16, 761	122, 325	50, 069	195, 956	3, 232	41, 712	398, 100	2, 287, 418
1915	209, 132	1, 152, 778	5. 51	8, 864	62, 569	23, 718	90, 367	1, 343	12, 433	243, 057	1, 318, 147
1916	253, 707	1, 326, 684	5. 22	2, 501	12, 134	42, 478	163, 421	180	1, 994	298, 866	1, 504, 233
1917	241, 029	1, 315, 769	5. 46	88	709	26, 581	123, 439	338	2, 142	268, 036	1, 442, 059
1918	168, 100	1, 153, 240	6. 86	114	983	26, 984	163, 484	137	1, 087	195, 335	1, 318, 794

EXPORTS.

Clay exported from the United States, 1916–1918.[a]

Year.	Fire clay.		All other.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1916	45, 752	$144, 552	27, 941	$145, 970	73, 693	$290, 522
1917	54, 023	268, 093	29, 194	178, 764	83, 217	446, 857
1918	60, 206	333, 880	24, 348	192, 053	84, 554	525, 933

[a] Figures not available prior to 1916.

CLAY PRODUCTS.

PRODUCTION.

Value of the clay products of the United States in 1917 and 1918, and increase or decrease in 1918, by products.

Product.	1917	1918	Increase or decrease in 1918.	
			Value.	Per cent.
Common brick	$47,936,344	$38,782,458	−$9,153,886	−19.1
Vitrified brick or block	10,664,560	7,145,359	− 3,519,201	−33 0
Face brick	10,391,368	6,095,120	− 4,296,248	−41.3
Fancy or ornamental brick	192,072	73,086	− 118,986	−61.9
Enameled brick	889,899	480,772	− 409,127	−46.0
Draintile	11,008,163	8,196,199	− 2,811,964	−25.5
Sewer pipe	17,307,211	15,333,673	− 1,973,538	−11.4
Architectural terra cotta	6,173,550	2,658,693	− 3,514,857	−56.9
Fireproofing and hollow building tile	13,255,433	13,037,102	− 218,331	− 1.6
Tile, not drain	6,821,221	5,082,069	− 1,739,152	−25.5
Stove lining	619,882	673,953	+ 54,071	+ 8.7
Fire brick	42,501,669	51,647,639	+ 9,145,970	+21.5
Miscellaneous	8,588,879	7,455,577	− 1,133,302	−13.2
Total brick and tile	176,350,251	156,661,700	−19,688,551	−11.2
Total pottery	56,162,522	65,222,951	+ 9,060,429	+16.1
Grand total	232,512,773	221,884,651	−10,628,122	− 4.6

IMPORTS.

Value of clay products imported and entered for consumption in the United States, 1913–1918.

Year.	Pottery.								Brick, fire brick, tile, etc.	Grand total.
	Brown earthen and common stone ware.[a]	Tobacco pipes and pipe bowls of clay.	Earthenware and crockery composed of a nonvitrified absorbent body.		China and porcelain.		Sanitary earthenware, decorated and not decorated.	Total.		
			Not decorated.	Decorated.	Not decorated.	Decorated.				
1913	$238,611	$31,806	[b] $81,978	[b] $523,803	[c] $1,067,209	[c] $8,273,681	....	$10,217,088	$276,677	$10,493,765
1914	312,934	40,548	438,460	1,968,561	727,725	4,910,365	....	8,398,593	207,644	8,606,237
1915	227,017	15,155	272,795	1,538,732	458,302	4,116,085	....	6,628,086	171,801	6,799,887
1916	264,715	10,378	173,192	1,669,712	289,219	3,177,998	$15,371	5,600,585	165,080	5,765,665
1917	518,965	8,209	235,104	1,960,150	157,658	3,409,527	43,701	6,333,314	309,259	6,642,573
1918	436,207	4,716	317,501	2,147,486	200,328	3,269,008	18,334	6,393,580	290,620	6,684,200

[a] Including Rockingham ware and miscellaneous pottery products.

[b] Figures cover period from Oct. 4 to Dec. 31.

[c] Including wares classified under the act of 1913 as china and porcelain wares composed of a vitrified nonabsorbent body: Not decorated, $244,983; decorated, $2,201,851. After 1913 only wares composed of a vitrified nonabsorbent body are included.

EXPORTS.

Value of clay products of domestic manufacture exported from the United States, 1913–1918.

Year.	Building brick.	Fire brick.	Tile (except drain).	Earthen and stone ware.	China.	Sanitary earthenware.	All other.	Total.
1913	$689,515	$1,121,590	$851,463	$410,050	$149,281	....	$1,566,340	$4,788,239
1914	524,239	734,134	658,695	390,693	136,209	....	1,134,035	3,578,005
1915	279,336	975,089	276,785	297,127	160,710	[a] $105,615	610,578	2,705,240
1916	189,668	2,406,184	403,184	600,377	262,119	214,076	779,922	4,855,530
1917	196.207	4,011,546	450,422	805,784	422,641	323,558	743,105	6,953,263
1918	117,263	5,001,057	582,051	783,577	318,448	377,527	752,651	7,932,574

[a] Figures cover period from July 1 to Dec. 31.

COAL.

PRODUCTION.

Coal produced in the United States, 1913–1918.

Year.	Pennsylvania anthracite.		Bituminous.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	91,524,922	$195,181,127	478,435,297	$565,234,952	569,960,219	$760,416,079
1914	90,821,507	188,181,399	422,703,970	493,309,244	513,525,477	681,490,643
1915	88,995,061	184,653,498	442,624,426	502,037,688	531,619,487	686,691,186
1916	87,578,493	202,009,561	502,519,682	665,116,077	590,098,175	867,125,638
1917	99,611,811	283,650,723	551,790,563	1,249,272,837	651,402,374	1,532,923,560
1918	98,826,084	336,480,347	579,385,820	1,491,809,940	678,211,904	1,828,290,287

Coal produced in the United States in 1917, by States.

State.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Made into coke at mines (short tons).	Total quantity (short tons).	Total value.
Alabama	15,272,716	508,398	641,733	3,645,227	20,068,074	$45,616,992
Alaska		53,955			53,955	265,317
Arkansas	2,009,408	59,104	75,067		2,143,579	5,492,777
California and Idaho	2,800	3,383	240		6,423	14,791
Colorado	9,770,529	450,392	304,492	1,957,923	12,483,336	27,669,129
Georgia	37,855	1,284	7,200	72,689	119,028	301,391
Illinois	80,283,345	3,541,792	2,374,250		86,199,387	162,281,822
Indiana	24,991,177	905,601	642,551		26,539,329	52,940,106
Iowa	7,954,466	784,970	226,394		8,965,830	21,096,408
Kansas	6,838,507	161,004	185,464		7,184,975	16,618,277
Kentucky	25,674,798	893,580	639,977	599,616	27,807,971	60,297,653
Maryland	4,582,436	104,578	58,910		4,745,924	11,667,852
Michigan	1,244,795	82,045	47,965		1,374,805	4,426,314
Missouri	4,942,689	576,079	151,781		5,670,549	13,755,864
Montana	3,882,919	176,066	167,704		4,226,689	8,919,136
New Mexico	2,927,954	44,636	36,449	991,488	4,000,527	7,455,166
North Dakota	559,571	196,900	34,077		790,548	1,425,750
Ohio	37,462,479	2,534,344	751,281	630	40,748,734	100,897,148
Oklahoma	4,152,162	45,492	189,190		4,386,844	12,335,413
Oregon	13,736	9,087	5,504		28,327	95,663
Pennsylvania (bituminous)	128,965,937	5,275,741	3,499,727	34,706,737	172,448,142	421,268,808
South Dakota	647	7,395			8,042	23,346
Tennessee	5,170,586	135,348	164,698	723,589	6,194,221	13,592,998
Texas	2,292,358	14,102	49,355		2,355,815	4,177,608
Utah	3,292,758	77,028	86,128	669,316	4,125,230	8,531,382
Virginia	7,733,626	173,535	145,231	2,034,699	10,087,091	20,125,713
Washington	3,614,329	71,606	166,399	157,568	4,009,902	10,727,362
West Virginia	77,996,698	2,494,393	1,194,951	4,755,625	86,441,667	200,659,368
Wyoming	8,179,694	125,484	270,441		8,575,619	16,593,283
Total bituminous	469,850,975	19,507,322	12,117,159	50,315,107	551,790,563	1,249,272,837
Pennsylvania (anthracite)	86,788,848	2,382,362	10,440,601		99,611,811	283,650,723
Grand total	556,639,823	21,889,684	22,557,760	50,315,107	651,402,374	1,532,923,560

Coal produced in the United States in 1918, by States.

State.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons.)	Used at mines for steam and heat (short tons).	Made into coke at mines (short tons).	Total quantity (short tons).	Total value.
Alabama	16,061,991	304,038	593,739	2,225,194	19,184,962	$54,752,329
Alaska	67,267	6,384	1,955		75,606	411,850
Arkansas	2,111,992	41,457	73,920		2,227,369	8,172,376
California and Idaho	5,800	600			6,400	17,250
Colorado	10,580,811	436,338	311,009	1,079,413	12,407,571	33,404,743
Georgia	21,725	888	6,250	37,853	66,716	239,377
Illinois	83,268,864	3,641,044	2,381,197		89,291,105	206,860,291
Indiana	28,961,651	941,707	775,276		30,678,634	70,384,601
Iowa	7,399,030	602,556	190,609		8,192,195	24,703,237
Kansas	7,188,358	173,330	200,259		7,561,947	22,028,142
Kentucky	29,350,941	1,049,985	678,090	533,601	31,612,617	80,666,842
Maryland	4,343,293	98,288	55,716		4,497,297	12,466,189
Michigan	1,280,658	98,954	85,206		1,464,818	5,615,097
Missouri	5,119,591	385,896	162,243		5,667,730	17,126,498
Montana	4,177,894	179,079	175,532		4,532,505	11,444,875
New Mexico	2,836,801	39,075	39,271	1,108,092	4,023,239	10,787,082
North Carolina	466	42	912		1,420	6,745
North Dakota	526,046	173,744	19,943		719,733	1,629,668
Ohio	42,888,610	2,015,720	908,613		45,812,943	118,095,518
Oklahoma	4,567,930	37,600	207,917		4,813,447	17,508,884
Oregon	4,112	3,946	5,270		13,328	37,454
Pennsylvania(bituminous)	137,492,980	4,984,384	3,612,890	32,460,487	178,550,741	463,159,736
South Dakota	640	7,302			7,942	22,230
Tennessee	5,904,593	148,130	181,901	596,424	6,831,048	19,305,203
Texas	2,204,266	11,854	45,015		2,261,135	5,937,997
Utah	4,238,718	64,827	94,978	738,302	5,136,825	13,937,097
Virginia	8,188,502	392,712	107,519	1,601,075	10,289,808	25,865,895
Washington	3,659,830	74,315	193,606	154,461	4,082,212	14,132,869
West Virginia	81,579,916	2,636,785	1,159,951	4,559,187	89,935,839	230,508,846
Wyoming	9,055,252	130,777	252,659		9,438,688	22,581,019
Total bituminous	503,088,528	18,681,757	12,521,446	45,094,089	579,385,820	1,491,809,940
Pennsylvania (anthracite)	85,927,696	2,674,439	10,223,949		98,826,084	336,480,347
Grand total	589,016,224	21,356,196	22,745,395	45,094,089	678,211,904	1,828,290,287

Coal produced per man employed, 1913–1918.

Year.	Anthracite.				Bituminous.			
	Men employed.	Days worked.	Average tonnage per man per day (short tons).	Average tonnage per man per year (short tons).	Men employed.	Days worked.	Average tonnage per man per day (short tons).	Average tonnage per man per year (short tons).
1913	175,745	257	2.02	520	571,882	232	3.61	837
1914	179,679	245	2.06	505	583,506	195	3.71	724
1915	176,552	230	2.19	504	557,456	203	3.91	794
1916	159,869	253	2.16	548	561,102	230	3.90	896
1917	154,174	285	2.27	646	603,143	243	3.77	915
1918	147,121	293	2.29	672	615,305	249	3.78	942

IMPORTS.

Coal, anthracite and bituminous, imported, 1913-1918.

Year.	Anthracite.		Bituminous.		Total.	
	Quantity (short tons).	Value.	Quantity (shorttons).	Value.	Quantity (short tons).	Value.
1913	1,031	$5,697	1,611,519	$3,856,811	1,612,550	$3,862,508
1914	21,668	37,998	1,540,353	3,889,821	1,562,021	3,927,819
1915	3,357	14,922	1,703,785	4,398,425	1,707,142	4,413,347
1916	6,376	19,316	1,713,837	4,714,433	1,720,213	4,733,749
1917	12,530	46,523	1,448,453	4,795,110	1,460,983	4,841,633
1918	37,272	204,385	1,457,073	6,694,081	1,494,345	6,898,466

EXPORTS.

Coal, anthracite and bituminous, exported, 1913-1918.

Year.	Anthracite.		Bituminous.[a]		Total.[a]	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	4,652,912	$21,959,850	20,145,168	$45,449,664	24,798,080	$67,409,514
1914	4,289,873	20,211,072	15,458,072	34,104,903	19,747,945	54,315,975
1915	3,965,255	18,429,255	18,776,640	42,817,341	22,741,895	61,246,596
1916	4,665,530	22,470,147	21,254,627	45,828,092	25,920,157	68,298,239
1917	6,007,306	30,909,798	23,839,558	79,502,654	29,846,864	110,412,452
1918	4,967,808	29,215,689	22,350,730	78,664,856	27,318,538	107,880,545

[a] Exclusive of bunker coal.

COBALT.

PRODUCTION.

Cobalt ores were mined only in Idaho where the Haynes Stellite Co. produced 55 tons of concentrates in 1918, carrying 17.74 per cent of cobalt (19,514 pounds), from 4,000 tons of ore. Most of the cobalt used in this country has been imported from Canada, where it is obtained as a by-product from silver ores mined in the Cobalt district.

IMPORTS.

Cobalt, cobalt ore and zaffer, and cobalt oxide imported for consumption in the United States, 1909-1918.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1909	12,132	$11,696	1914	334,556	$274,538
1910	14,935	6,352	1915	208,047	219,111
1911	602,454	59,151	1916	343,409	367,245
1912	791,242	83,080	1917	500,200	645,771
1913	209,396	95,735	1918	712,987	919,798

COKE.

PRODUCTION.

Coke produced in the United States, 1913–1918.

Year.	By-product coke.				Beehive coke.				Total.	
	Quantity (short tons).	Percentage of total.	Value.	Percentage of total.	Quantity (short tons).	Percentage of total.	Value.	Percentage of total.	Quantity (short tons).	Value.
1913	12,714,700	27.5	$48,637,852	37.7	33,584,830	72.5	$80,284,421	62.3	46,299,530	$128,922,273
1914	11,219,943	32.5	38,080,167	43.1	23,335,971	67.5	50,254,050	56.9	34,555,914	88,334,217
1915	14,072,895	33.8	48,558,325	46.0	27,508,255	66.2	56,945,543	54.0	41,581,150	105,503,868
1916	19,069,361	35.0	75,373,070	44.1	35,464,224	65.0	95,468,127	55.9	54,533,585	170,841,197
1917	22,439,280	40.4	138,643,153	46.5	33,167,548	59.6	159,599,864	53.5	55,606,828	298,243,017
1918	25,997,580	46.0	193,018,785	50.5	30,480,792	54.0	189,305,583	49.5	56,478,372	382,324,368

Statistics of the manufacture of coke in the United States, 1913–1918.

Year.	In operation.		Coal used (short tons).	Percentage yield of coke from coal.	Coke produced (short tons).	Total value of coke at ovens.	Average price of coke per ton at ovens.
	Establishments.	Ovens.					
1913	444	72,008	69,239,190	66.9	46,299,530	$128,922,273	$2.78
1914	359	54,638	51,623,750	66.9	34,555,914	88,334,217	2.56
1915	354	54,967	61,832,898	67.2	41,581,150	105,503,868	2.54
1916	389	72,888	81,609,460	66.8	54,533,585	170,841,197	3.13
1917	398	75,985	83,752,371	66.4	55,606,828	298,243,017	5.36
1918	403	70,221	85,028,018	66.4	56,478,372	382,324,368	6.77

Coke produced in beehive and by-product ovens in the United States in 1917, by States.

State.	Beehive coke.				
	Active ovens.	Coal used (short tons).	Percentage yield of coke from coal.	Coke produced (short tons).	Value of coke at ovens.
Alabama	5,493	3,658,598	58.8	2,151,828	$12,138,161
Colorado	2,867	1,784,631	62.3	1,112,449	5,479,734
Georgia	151	72,689	54.5	39,589	322,175
Kentucky	801	599,626	55.3	331,532	1,794,315
New Mexico	1,134	936,411	61.7	577,679	2,805,277
Ohio	198	224,952	65.7	147,826	1,131,753
Pennsylvania	44,534	36,594,563	65.1	23,816,420	111,262,905
Tennessee	1,266	695,841	54.0	376,080	1,831,780
Virginia	3,029	2,093,943	62.3	1,304,230	5,785,934
Washington	254	831,042	56.7	471,187	2,597,101
Utah	726				
West Virginia	8,234	4,754,316	59.7	2,838,728	14,450,729
	68,687	52,246,612	63.5	33,167,548	159,599,864

State.	By-product coke.				
	Active ovens.	Coal used (short tons).	Percentage yield of coke from coal.	Coke produced (short tons).	Value of coke at ovens.
Alabama	831	3,980,243	68.9	2,740,761	$16,256,111
Illinois	619	3,233,669	70.8	2,289,833	14,455,539
Indiana	861	4,817,942	73.5	3,540,718	21,831,302
Kentucky	108	742,162	71.6	531,539	2,324,948
Maryland	120	733,184	70.8	518,810	3,925,418
Massachusetts	317	738,873	80.5	595,113	(a)
Minnesota	152	676,881	67.7	490,272	3,468,355
New Jersey	260	621,699	68.1	423,361	(a)
New York	615	1,401,458	70.9	993,184	6,889,424
Ohio	1,009	5,141,046	69.0	3,546,476	22,342,011
Pennsylvania	1,629	5,716,221	71.6	4,095,605	24,435,135
Tennessee	12	63,793	55.3	35,246	199,492
Washington	5	45,025	58.5	26,346	201,831
West Virginia	214	727,778	70.2	511,033	2,264,354
Michigan	258	2,865,785	73.3	2,100,983	[b] 20,049,233
Missouri	56				
Wisconsin	232				
	7,298	31,505,759	71.2	22,439,280	138,643,153

[a] Included with Michigan, Missouri, and Wisconsin.
[b] Includes also value of Massachusetts and New Jersey coke.

Coke produced in beehive and by-product ovens in the United States in 1917, by States—Continued.

State.	Total.			
	Coal used (short tons).	Coke produced (short tons).	Percentage of total.	Value of coke at ovens.
Alabama	7,638,841	4,892,580	8.8	$28,394,272
Colorado	1,784,631	1,112,449	2.0	5,479,734
Georgia	72,689	39,589	.1	322,175
Illinois	3,233,669	2,289,833	4.1	14,455,539
Indiana	4,817,942	3,540,718	6.4	21,831,302
Kentucky	1,341,788	863,071	1.6	4,119,263
Maryland	733,184	518,810	.9	3,925,418
Massachusetts	738,873	595,113	1.1	(a)
Minnesota	676,881	490,272	.9	3,468,355
New Jersey	621,699	423,361	.8	(a)
New Mexico	936,411	577,679	1.0	2,805,277
New York	1,401,458	993,184	1.8	6,889,424
Ohio	5,365,998	3,694,302	6.6	23,473,764
Pennsylvania	42,310,784	27,912,025	50.2	135,698,040
Tennessee	759,634	411,326	.7	2,031,272
Virginia	2,093,943	1,304,230	2.3	5,785,934
Washington Utah	876,067	497,533	.9	2,798,932
West Virginia	5,482,094	3,349,761	6.0	16,715,083
Michigan Missouri Wisconsin	2,865,785	2,100,983	3.8	[b] 20,049,233
	83,752,371	55,606,828	100.0	298,243,017

[a] Included with Michigan, Missouri, and Wisconsin.
[b] Includes also value of Massachusetts and New Jersey coke.

Coke produced in beehive and by-product ovens in the United States in 1918, by States.

State.	Beehive coke.		By-product coke.		Total.		
	Coal used (short tons).	Coke produced (short tons).	Coal used (short tons).	Coke produced (short tons).	Coal used (short tons).	Coke produced (short tons.)	Percentage of total production.
Alabama	2,949,992	1,717,721	3,877,634	2,634,451	6,827,626	4,352,172	7.7
Colorado	1,216,154	758,784	345,877	230,663	1,562,031	989,447	1.8
Georgia	38,280	22,048	......	......	38,280	22,048	......
Illinois	......	......	3,199,620	2,285,610	3,199,620	2,285,610	4.0
Indiana	......	......	5,318,900	3,898,215	5,318,900	3,898,215	6.9
Kentucky	533,346	301,036	723,113	517,749	1,256,459	818,785	1.4
Maryland	......	......	696,576	474,368	696,576	474,368	.8
Massachusetts	......	......	676,866	556,397	676,866	556,397	1.0
Michigan	......	......	(a)	(a)	(a)	(a)	(a)
Minnesota	......	......	1,069,775	784,065	1,069,775	784,065	1.4
Missouri	......	......	(a)	(a)	(a)	(a)	(a)
New Jersey	......	......	994,300	682,148	994,300	682,148	1.2
New Mexico	1,047,675	597,072	......	......	1,047,675	597,072	1.1
New York	......	......	1,516,580	1,069,587	1,516,580	1,069,587	1.9
Ohio	223,200	138,909	7,775,623	5,226,334	7,998,823	5,365,243	9.5
Oklahoma	(a)	(a)	......	......	(a)	(a)	(a)
Pennsylvania	34,059,026	22,136,664	6,514,868	4,586,981	40,573,894	26,723,645	47.3
Tennessee	564,920	302,637	166,157	124,469	731,077	427,106	.8
Utah	(a)	(a)	......	......	(a)	(a)	(a)
Virginia	2,042,429	1,234,256	......	......	2,042,429	1,234,256	2.2
Washington	154,460	93,659	47,410	30,129	201,870	123,788	.2
West Virginia	4,516,108	2,716,613	853,684	603,393	5,369,792	3,320,006	5.9
Wisconsin	......	......	(a)	(a)	(a)	(a)	(a)
Undistributed	814,707	461,393	3,090,738	2,293,021	3,905,445	2,754,414	4.9
	48,160,297	30,480,792	36,867,721	25,997,580	85,028,018	56,478,372	100.0

[a] Included under "Undistributed."

IMPORTS AND EXPORTS.

Coke imported and exported, 1913–1918.

Year.	Imports for consumption.		Exports.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	101,212	$435,157	987,395	$3,309,930
1914	133,226	551,104	663,585	2,233,686
1915	53,222	222,382	895,509	3,092,498
1916	54,955	249,514	1,174,645	4,202,236
1917	24,872	146,451	1,409,320	8,543,746
1918	30,168	221,880	1,687,824	11,861,408

BEEHIVE OVENS.

Beehive coke ovens at end of each year, 1913–1918.

State.	1913	1914	1915	1916	1917	1918
Alabama	9,534	8,535	8,568	8,806	8,813	8,586
Colorado	3,588	3,573	3,573	3,573	3,573	2,724
Georgia	251	201	201	201	201	201
Kansas	2	2	2	2	2	2
Kentucky	995	1,097	1,097	1,097	1,097	1,077
Montana	351	351	112	....	....	....
New Mexico	1,030	1,030	1,030	1,060	1,204	1,154
Ohio	322	321	321	321	332	272
Oklahoma	260	260	50	50	50	304
Pennsylvania	53,466	52,553	53,112	52,416	49,949	48,588
Tennessee	2,427	2,303	2,302	2,228	2,228	2,328
Utah	726	726	726	726	726	819
Virginia	5,695	5,435	5,229	5,146	4,979	4,042
Washington	331	331	331	331	331	408
West Virginia	17,706	17,000	16,228	15,396	14,314	14,130
Wisconsin	228	228	228	228	228	....
	96,962	93,946	93,110	91,581	88,027	84,635

BY-PRODUCT OVENS.

By-product ovens at end of each year, 1913–1918.

State.	1913		1914		1915		1916		1917		1918	
	Built.	Building.	Built.	Building.	Built.	Building.	Built.	Building.	Built.	Building.	Built.	Building.
Alabama	700	20	750	....	750	....	743	97	847	....	847	324
Colorado	....	....	....	....	....	....	....	120	....	120	120	....
Illinois	568	58	586	40	626	....	626	....	626	....	626	88
Indiana	749	41	789	33	812	30	842	44	886	260	1,026	190
Kentucky	54	....	54	....	54	54	108	....	108	....	108	....
Maryland	(a)	120	120	....	120	....	120	240	120	240	180	180
Massachusetts	400		400	....	400	....	400	....	400	....	400	....
Michigan	205	....	205	....	205	24	229	40	269	....	269	120
Minnesota	50	90	140	90	120	20	155	65	155	65	220	....
Missouri	....	56	....	56	56	....	56	....	56	....	56	....
New Jersey	150	....	150	....	150	....	150	110	260	55	260	55
New York	555	....	555	100	555	100	555	160	615	....	615	60
Ohio	149	119	217	51	343	657	916	472	1,108	760	1,658	....
Pennsylvania	1,592	....	1,522	262	1,744	212	1,956	700	1,956	700	2,368	638
Rhode Island	....	....	....	....	....	....	....	....	....	....	....	40
Tennessee	....	....	....	12	12	....	12	....	12	24	24	....
Washington	....	....	5	....	5	....	5	....	5	....	20	....
West Virginia	120	....	120	....	120	94	214	....	214	....	214	120
Wisconsin	196	....	196	....	196	....	196	36	232	36	268	....
	[a]5,488	504	5,809	644	6,268	1,191	7,283	2,084	7,869	2,260	9,279	1,815

[a] At the close of 1913 the 200 ovens at Sparrows Point works of the Maryland Steel Co. that were operated during the year were being torn down to be replaced by 120 ovens of larger dimensions.

COKE-OVEN BY-PRODUCTS.

PRODUCTION.

By-products from coke-oven operations sold or used in the United States, 1917 and 1918.

Product.	1917			1918		
	Quantity.	Value.	Average price.	Quantity.	Value.	Average price.
Tar....gallons..	221,999,264	$5,566,302	$0.025	200,233,002	$6,364,972	$0.032
Ammonia:						
Sulphate....pounds..	352,722,848	11,973,468	.034	423,515,836	19,061,777	.045
Liquor....gallons..	7,055,039	1,106,950	.157	(a)	(a)	(a)
Anhydrous or free ammonia [b]....pounds..	47,784,345	4,823,446	.101	61,442,933	7,381,174	.120
Surplus gas:						
Illuminating....M cubic feet..	21,289,102	3,210,398	.155	33,437,991	7,130,113	.213
Household purposes....do....	7,271,102	2,859,452	.410			
Industrial purposes....do....	102,466,371	5,290,485	.052	124,920,488	6,569,402	.053
Benzol products:						
Crude light oil....gallons..	7,516,695	1,490,733	.198	3,764,272	963,042	.256
Secondary light oil....do....	326,540	30,538	.094	121,191	15,472	.128
Benzol....do....	36,804,228	16,576,865	.450	43,441,980	11,966,367	.275
Toluol....do....	7,395,174	10,140,013	1.371	8,541,366	12,249,702	1.434
Solvent naphtha....do....	2,115,516	351,130	.166	3,123,815	439,983	.141
Other oils....do....	229,113	65,925	.288	571,752	53,880	.094
Naphthalene crude....pounds..	17,276,044	569,449	.033	10,403,758	287,581	.028
Naphthalene refined....pounds..				5,486,689	362,648	.066
Other products [c]....	....	1,267,322	......	....	1,756,345	......
	....	65,322,476	......	....	74,602,458	......

[a] It has been possible for 1918 to convert all ammonia reported as liquor to its equivalent in sulphate or anhydrous.

[b] Includes liquor and sulphate sold on pound basis of NH_3.

[c] 1917: Sodium ferrocyanide, drip oil, spent oxide, retort carbon, and residue; 1918: Sodium ferrocyanide, pyridin oil, nut coke, drip oil, spent oxide, residue, coal-tar paint, and wash oil.

COPPER.

SUMMARY OF STATISTICS.

Summary of statistics of the copper industry in the United States, 1913–1918.

	1913	1914	1915
Production of copper:			
Smelter output....pounds..	1,224,484,098	1,150,137,192	1,388,009,527
Mine production....do....	1,235,569,727	1,148,431,437	1,488,071,528
Refinery production of new copper—			
Electrolytic....do....	1,022,497,601	991,573,073	1,114,345,342
Lake....do....	155,715,286	158,009,748	236,757,062
Casting and pig....do....	58,611,026	60,840,368	36,603,119
Total domestic....do....	1,236,823,913	1,210,423,189	1,387,705,523
Total domestic and foreign....do....	1,615,067,782	1,533,781,394	1,634,204,448
Total new and old copper....do....	1,888,000,000	1,790,000,000	2,027,000,000
Total ore produced....short tons..	36,361,101	35,187,118	43,415,133
Copper ore produced....do....	36,336,682	35,175,541	43,404,182
Average yield of copper....per cent..	1.67	1.60	1.66
Average price per pound....cents..	15.5	13.3	17.5
Imports (unmanufactured)....pounds..	408,778,954	306,350,827	315,698,449
Exports of metallic copper....do....	926,241,092	840,080,922	681,917,855
Consumption:			
Total new copper....do....	812,268,639	701,624,158	1,136,618,187
Total new and old copper....do....	1,085,000,000	958,000,000	1,529,000,000
World's production....do....	2,133,295,000	2,023,344,000	2,325,994,000
Value of production in the United States....	$189,795,035	$152,968,000	$242,902,000

Summary of statistics of the copper industry in the United States, 1913–1918—Contd.

	1916	1917	1918
Production of copper:			
Smelter output..........pounds..	1,927,850,548	1,886,120,721	1,908,533,595
Mine production..........do....	2,005,875,312	1,895,434,349	1,910,022,841
Refinery production of new copper—			
Electrolytic..........do....	1,579,620,513	1,452,744,593	1,560,327,422
Lake..........do....	269,794,531	268,508,091	231,096,158
Casting and pig..........do....	39,337,155	152,293,487	91,450,611
Total domestic..........do....	1,888,752,199	1,873,546,171	1,882,874,191
Total domestic and foreign..........do....	2,259,387,315	2,428,546,171	2,432,385,290
Total new and old copper..........do....	2,959,000,000	3,195,000,000	3,138,000,000
Total ore produced..........short tons..	57,953,357	58,514,325	62,304,767
Copper ore produced..........do....	57,863,365	58,482,694	62,289,069
Average yield of copper..........per cent..	1.70	1.60	1.51
Average price per pound..........cents..	24.6	27.3	24.7
Imports (unmanufactured)..........pounds..	462,335,980	556,420,297	575,805,115
Exports of metallic copper..........do....	784,006,486	1,125,647,336	744,243,481
Consumption:			
Total new copper..........do....	1,478,881,871	1,394,829,715	1,661,669,576
Total new and old copper..........do....	2,179,000,000	2,162,000,000	2,367,000,000
World's production..........do....	2,993,725,000	3,147,258,000	(a)
Value of production in the United States..........	$474,288,000	$514,911,000	$471,408,000

a Figures not yet available.

PRODUCTION.

Copper produced in the United States from domestic ores, 1913–1918.

[Smelter output, in pounds fine.]

State.	1913	1914	1915	1916	1917	1918
Alaska..........	23,423,070	24,985,847	70,695,286	113,823,064	84,759,086	67,081,648
Arizona..........	404,278,809	382,449,922	432,467,690	694,847,307	719,035,514	769,521,729
California..........	32,492,265	29,784,173	37,658,444	43,400,876	44,933,846	44,150,761
Colorado..........	9,052,104	7,316,066	7,272,178	9,536,193	10,054,951	7,591,570
Georgia..........	....	....	....	803,699	930,691	397,078
Idaho..........	8,711,490	5,875,205	6,217,728	7,248,794	6,446,224	5,836,795
Maine..........	....	....	....	....	34,872	501,169
Maryland..........	....	12,248	15,426	126,965	291,501	....
Michigan..........	155,715,286	158,009,748	238,956,410	269,794,531	268,508,091	231,096,158
Missouri..........	576,204	53,519	306,406	377,575	407,141	232,073
Montana..........	285,724,467	236,805,845	268,263,040	352,139,768	276,225,977	326,426,761
Nevada..........	85,209,536	60,122,904	67,757,322	100,816,724	115,028,161	106,266,603
New Jersey..........	....	....	....	4,115	....	....
New Mexico..........	50,196,881	64,204,703	62,817,234	79,863,439	107,593,615	96,559,580
North Carolina..........	180	19,712	33,383	5,961	125,004	79,200
Oregon..........	77,812	5,599	797,471	2,433,567	1,105,097	2,630,499
Pennsylvania..........	245,337	422,741	....	904	115,000	34,500
South Carolina..........	....	....	....	....	210,000	....
Tennessee..........	19,489,654	18,661,112	18,205,308	14,556,278	16,093,757	15,053,568
Texas..........	39,008	34,272	38,971	86,463	2,061,129	13,851
Utah..........	148,057,450	160,589,660	175,177,695	232,335,950	227,840,447	230,964,908
Vermont..........	5,771	....	23,995	324,400	102,522	896,630
Virginia..........	46,961	17,753	50,008	1,066,143	146,912	1,248
Washington..........	732,742	683,602	903,661	2,473,481	2,051,416	2,330,568
Wyoming..........	362,235	17,082	351,871	1,784,351	2,019,767	866,698
Undistributed..........	46,836	65,479	....	....	....	....
	1,224,484,098	1,150,137,192	1,388,009,527	1,927,850,548	1,886,120,721	1,908,533,595

Primary and secondary copper produced by regular refining plants and imported, 1913–1918, in pounds.

	1913	1914	1915
Primary:			
Domestic—			
Electrolytic	[a] 1,022,497,601	[a] 991,573,073	[a] 1,114,345,342
Lake	155,715,286	158,009,748	[b] 236,757,062
Casting	22,606,040	21,506,325	21,555,129
Pig and best select	36,004,986	39,334,043	15,047,990
	[a] 1,236,823,913	[a] 1,210,423,189	[a] 1,387,705,523
Foreign (electrolytic)	[a] 378,243,869	[a] 323,358,205	[a] 246,498,925
	1,615,067,782	1,533,781,394	1,634,204,448
Secondary:			
Electrolytic	14,862,577	27,702,928	38,156,789
Casting	22,360,182	4,224,052	21,417,901
	37,222,759	31,926,980	59,574,690
Total output	1,652,290,541	1,565,708,374	1,693,779,138

	1916	1917	1918
Primary:			
Domestic—			
Electrolytic	[a] 1,579,620,513	[a] 1,452,744,593	[a] 1,560,327,422
Lake	269,794,531	268,508,091	231,096,158
Casting	12,469,050	69,916,911	15,284,635
Pig and best select	26,868,105	82,376,576	76,165,976
	[a] 1,888,752,199	[a] 1,873,546,171	[a] 1,882,874,191
Foreign—			
Electrolytic	[a] 370,635,116	[a] [c] 555,000,000	[a] [c] 492,181,364
Casting and best select			57,329,735
	2,259,387,315	2,428,546,171	2,432,385,290
Secondary:			
Electrolytic	78,585,296	66,337,771	34,674,062
Casting	25,838,511	12,779,125	9,018,049
	104,423,807	79,116,896	43,692,111
Total output	2,363,811,122	2,507,663,067	2,476,077,401

[a] The separation of refined copper into metal of domestic and foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible.

[b] Some Lake copper was refined at seaboard plants and doubtless marketed under some brand other than Lake. This has been excluded from the Lake copper.

[c] Includes refined copper imported.

In addition to their output of metallic copper the regular refining companies produced in 1918 bluestone having a copper content of 7,917,000 pounds.

STOCKS.

Stocks of refined copper.

	Pounds.
Jan. 1, 1917	128,000,000
Jan. 1, 1918	114,000,000
Jan. 1, 1919	180,000,000
Increase in 1919	66,000,000

In addition to the stocks of refined copper on hand January 1, 1919, 562,600,000 pounds of blister copper and material in process of refining was reported as at smelters in the United States, in transit from smelters to refiners, and at refineries, against 411,000,000 pounds on January 1, 1918.

CONSUMPTION.

Apparent domestic consumption of refined new copper, 1913–1918, in pounds.

	1913	1914	1915	1916	1917	1918
Total supply of new copper	1,615,067,782	1,533,781,394	1,634,204,448	2,259,387,315	2,428,546,171	2,432,385,290
Stock at beginning of year	105,497,683	90,385,402	173,640,501	82,429,666	128,055,229	114,000,000
Total available supply	1,720,565,465	1,624,166,796	1,807,844,949	2,341,816,981	2,556,601,400	2,546,385,290
Copper exported [a]	817,911,424	748,902,137	588,797,096	734,879,881	1,047,771,685	704,715,714
Stock at end of year	90,385,402	173,640,501	82,429,666	128,055,229	114,000,000	180,000,000
Total withdrawn from supply	908,296,826	922,542,638	671,226,762	862,935,110	1,161,771,685	884,715,714
Apparent consumption	812,268,639	701,624,158	1,136,618,187	1,478,881,871	1,394,829,715	1,661,669,576

[a] Includes unrefined black blister and converter copper (bars, pigs, and other forms) and refined in ingots, bars, rods, or other forms.

IMPORTS.

Copper imported into the United States in 1917 and 1918, in pounds.

1917.

Country.	Ore (copper content).	Concentrates (copper content).	Matte and regulus (copper content).	Unrefined black copper and copper in bars, pigs, or other forms.	Refined, in bars, plates, rods, or other forms.	Old and clippings for remanufacture.	Composition metal, copper chief value.
United Kingdom	75,591	....	174,546	....	225	5,550	109,131
Spain	371,902	....	....	....	....	....	....
Canada	31,126,511	38,951	....	40,571,284	765,980	15,321,755	9,801
Mexico	4,929,250	31,502,982	3,736,059	40,213,831	425,532	215,350	4,839
Chile	28,447,728	169,142	15,289,999	162,227,104	4,074,784	158,468	34,659
Cuba	40,100,956	4,913,440	328,966	....	8,590	650,282	186,934
Peru	4,644,455	472,232	768,898	100,302,275	....	90,574	54,465
Japan	....	607,554	....	6,393,524	1,101,776	110	....
Other countries	6,804,139	493,231	750,475	5,890,018	375,071	1,451,505	29,873
	116,500,532	38,197,532	21,018,943	355,598,036	6,751,958	17,893,594	429,702

1918.

Country.	Ore (copper content).	Concentrates (copper content).	Matte and regulus (copper content).	Unrefined black copper and copper in bars, pigs, or other forms.	Refined, in bars, plates, rods, or other forms.	Old and clippings for remanufacture.	Composition metal, copper chief value.
United Kingdom	39,220	....	773,076	112,738	200	300	54,945
Canada	30,060,903	870,066	787,821	37,881,986	4,951,617	935,112	39,210
Mexico	3,373,084	38,867,789	22,638,810	83,568,187	4,244,197	17,682	....
Chile	14,707,473	....	4,239,615	156,285,580	18,264,771	27,506	11,918
Cuba	23,861,119	4,761,704	94,080	....	....	550,164	56,347
Peru	1,200,879	....	2,380,831	81,492,209	8,693,200	6,342	4,259
Japan	....	....	....	827,404	336,022	....	....
Other countries	3,629,335	1,768,315	3,162,361	18,203,547	1,597,762	384,433	40,996
	76,872,013	46,267,874	34,076,594	378,371,651	38,087,769	1,921,539	207,675

EXPORTS.

Copper exported from the United States, 1917 and 1918, in pounds.

	1917	1918
Ore (copper content)	5,135,818	2,387,275
Concentrates (copper content)	821,477	872,564
Unrefined black blister and converter copper (bars, pigs, and other forms)	16,992,357	14,687,823
Refined in ingots, bars, rods, or other forms	1,030,779,328	690,027,891
Composition metal, copper chief value	[a] 1,228,032	186,260
Old and scrap	1,070,389	257,403
Pipes and tubes	[a] 7,260,833	4,109,226
Plates and sheets	42,664,931	19,471,584
Wire	26,879,498	15,689,554
	1,132,832,663	747,689,580

[a] Figures cover period beginning July 1.

PRICES.

[See statement on page 26A.]

CORUNDUM.

[See under Abrasive materials.]

CRYOLITE.

PRODUCTION.

No natural cryolite is produced in the United States, the entire supply used in this country being imported from Greenland. Recently small quantities of artificial cryolite have been produced by electrochemical processes.

IMPORTS.

Cryolite imported and entered for consumption in the United States, 1909–1918.

Year.	Quantity (long tons).	Value.	Average price per ton.	Year.	Quantity (long tons).	Value.	Average price per ton.
1909	1,278	$18,427	$14.42	1914	4,612	$94,424	$20.47
1910	36	2,343	65.08	1915	3,940	82,750	21.00
1911	2,007	47,093	23.46	1916	3,857	165,222	42.84
1912	2,126	48,293	22.72	1917	4,383	218,500	49.86
1913	2,559	52,557	20.54	1918	1,950	97,500	50.00

DIATOMACEOUS (INFUSORIAL) EARTH.

[See under Abrasive materials.]

EMERY.

[See under Abrasive materials.]

FELDSPAR.

PRODUCTION.

Feldspar sold by producers in the United States, 1909–1918.

Year.	Quantity (short tons).	Value.		Year.	Quantity (short tons).	Value.	
		At price for crude spar.	As sold (crude and ground).			At price for crude spar.	As sold (crude and ground).
1909	76,539	$195,639	$424,602	1914	135,419	$399,069	$629,873
1910	81,102	256,718	502,452	1915	105,118	336,667	489,223
1911	92,700	269,546	579,008	1916	132,681	404,689	702,278
1912	86,572	269,511	520,562	1917	141,924	474,767	728,838
1913	120,955	369,348	776,551	1918	99,120	429,989	674,346

Feldspar sold by producers in 1917 and 1918, by States, and the value at price for crude feldspar.

State.	1917		1918	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
California	7,874	$18,137	1,451	$8,839
Connecticut and New Hampshire [a]	11,710	43,160	[a] 5,942	[a] 29,419
Maine	35,527	131,994	25,376	105,430
Maryland	15,779	56,958	8,784	40,299
New York	13,462	44,290	12,631	58,076
North Carolina	47,559	131,442	40,020	160,275
Pennsylvania	10,013	48,786	4,916	27,651
	141,924	474,767	99,120	429,989

[a] No production from New Hampshire in 1918.

IMPORTS AND EXPORTS.

The United States imports nearly the whole of the Canadian production of feldspar and none from other countries. Imports and exports are not specifically shown by the Bureau of Foreign and Domestic Commerce.

CANADIAN PRODUCTION.

Feldspar produced in Canada, 1909–1918.[a]

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1909	12,783	$40,382	1914	18,060	$70,824
1910	15,809	47,667	1915	15,455	59,124
1911	17,723	51,939	1916	19,488	71,407
1912	13,733	30,916	1917	11,493	54,555
1913	15,935	56,841	1918	20,232	117,379

[a] Reports on mineral production of Canada, Canada Dept. Mines.

FERROALLOYS.

PRODUCTION.[a]

Ferroalloys of domestic manufacture shipped, 1916–1918.

Variety of alloy.	1916		1917		1918	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Ferromanganese	224,103	$30,123,493	260,225	$53,930,771	306,076	$69,045,678
Spiegeleisen	182,837	6,158,202	189,241	9,756,236	263,861	17,276,494
Ferrosilicon	166,308	5,273,088	175,079	8,562,182	171,756	11,864,904
Ferrophosphorus	12,966					
Ferrotungsten (50 per cent or more tungsten)	(b)	(b)	1,258	4,225,070	2,142	7,798,898
Other varieties [c]	3,524	8,726,909	8,218	7,257,465	7,033	9,447,969
	589,738	50,281,692	634,021	83,731,724	750,868	115,433,943

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[a] The quantity reported falls short of the actual production of the United States, as the output of certain electrically produced ferroalloys is not available for publication by the Geological Survey.

[b] Included with "Other varieties."

[c] 1916: Ferrochrome, ferromolybdenum, ferrotungsten, and ferrovanadium; 1917: Ferrocarbontitanium, ferrocerium, ferrochrome, ferromolybdenum, ferrouranium, and ferrovanadium; 1918: Ferrocarbontitanium, ferrocerium, ferrochrome, ferromolybdenum, ferrotitanium, ferrouranium, ferrovanadium, and ferrozirconium.

IMPORTS.

Ferroalloys imported for consumption in the United States, 1916–1918.

Variety of alloy.	1916		1917		1918	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Chrome or chromium and ferrochrome	10	$1,998	....	....	....	....
Ferrophosphorus	....	....	85	$5,458	10	$1,055
Ferrosilicon	6,740	384,384	9,740	691,684	5,540	424,932
Molybdenum and ferromolybdenum	....	....	....	....	32	19,280
Titanium and ferrotitanium	100	8,126	....	....	(a)	10
Tungsten and ferrotungsten	38	157,711	1	3,606	....	8
Ferromanganese	90,928	9,240,528	41,969	5,710,988	27,168	4,258,745
Spiegeleisen	....	....	3,968	291,594	1,969	228,012
	97,816	9,792,747	55,763	6,703,330	34,719	4,932,042

[a] Ten pounds.

EXPORTS.

Ferromanganese, ferrosilicon, tungsten, and ferrotungsten exported, 1916–1918.

Variety of alloy.	1916		1917		1918	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Ferromanganese	....	....	[a] 2,400	[a] $498,402	3,577	$806,087
Ferrosilicon	....	....	[a] 6,849	[a] 719,626	4,107	443,456
Tungsten and ferrotungsten	256	$1,352,631	1,038	4,122,653	550	2,545,087

[a] Figures cover six months, July to December.

FLUORSPAR.

SUPPLY.

Supplies of fluorspar in the United States, 1913–1918.

Year.	Sales of domestic spar.	Value.	Imports for consumption.	Value.	Apparent consumption.[a]	Value.
	Short tons.		*Short tons.*		*Short tons.*	
1913	115,580	$736,286	22,682	$71,463	138,262	$807,749
1914	95,116	570,041	10,205	38,943	105,321	608,984
1915	136,941	764,475	7,167	22,878	144,108	787,353
1916	155,735	922,654	12,323	54,000	168,058	976,654
1917	218,828	2,287,722	13,616	114,598	232,444	2,402,320
1918	263,817	5,465,481	12,572	169,364	276,389	5,634,845

[a] No exports have been reported.

PRODUCTION.

Domestic fluorspar sold, 1917 and 1918, by States.

State.	1917			1918		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
Arizona	(a)	(a)	(a)	364	$5,537	$15.21
Colorado	17,104	$196,633	$11.50	38,475	416,780	10.83
Illinois	156,676	1,373,333	8.77	132,798	2,887,099	21.74
Kentucky	43,639	697,566	15.98	87,604	2,069,185	23.62
New Mexico	.....	.....	.....	3,437	64,348	18.72
Other States [b]	1,409	20,190	14.33	1,139	22,532	19.78
	218,828	2,287,722	10.45	263,817	5,465,481	20.72

[a] Included in "Other States."
[b] 1917: Arizona and New Hampshire; 1918: New Hampshire, Utah, and Washington.

FULLER'S EARTH.

PRODUCTION.

Fuller's earth produced and marketed in the United States, 1909–1918.

Year.	Quantity (short tons).	Value.	Average price per ton.	Year.	Quantity (short tons).	Value.	Average price per ton.
1909	33,486	$301,604	$9.01	1914	40,981	$403,646	$9.85
1910	32,822	293,709	8.95	1915	47,901	489,219	10.21
1911	40,697	383,124	9.41	1916	67,822	706,951	10.42
1912	32,715	305,522	9.34	1917	72,567	772,087	10.64
1913	38,594	369,750	9.58	1918	84,468	1,146,354	13.57

Fuller's earth produced and marketed in the United States, 1917–1918.

State.	1917				1918			
	Number of operators.	Quantity (short tons).	Value.	Average price per ton.	Number of operators.	Quantity (short tons).	Value.	Average price per ton.
Alabama,[a] Florida, Georgia, and Massachusetts	7	67,397	$709,187	$10.52	8	73,395	$1,012,224	$13.79
Arkansas, California, Nevada,[a] and Texas	4	5,170	62,900	12.17	6	11,073	134,130	12.11
	11	72,567	772,087	10.64	14	84,468	1,146,354	13.57

[a] No production from Alabama and Nevada in 1917.

IMPORTS.

Fuller's earth imported and entered for consumption in the United States, 1909–1918.

Year.	Quantity (short tons).	Value.	Average price per ton.	Year.	Quantity (short tons).	Value.	Average price per ton.
1909	12,752	$101,151	$7.93	1914	24,977	$195,083	$7.81
1910	16,857	132,545	7.86	1915	19,441	152,493	7.84
1911	18,224	143,594	7.88	1916	16,801	139,664	8.31
1912	19,109	145,337	7.61	1917	16,994	176,417	10.38
1913	18,628	146,001	7.84	1918	12,607	165,535	13.13

EXPORTS.

Exports of fuller's earth are not reported separately.

GARNET (ABRASIVE).

[See under Abrasive materials.]

GAS (ARTIFICIAL) AND BY-PRODUCTS.

ARTIFICIAL GAS.

CONSUMPTION.

Artificial gas consumed in the United States, 1912–1918, by kinds.

	Sales (M cubic feet).	Value.	Average price (M cubic feet).
1912.			
Coal gas	35,202,124	$32,031,367	$0.91
By-product gas	54,491,248	4,650,517	.09
Oil gas and water gas	122,697,796	111,600,841	.91
1915.			
Coal gas	43,747,432	40,257,108	.92
By-product gas	84,355,914	8,624,899	.10
Oil gas and water gas	138,100,902	124,950,125	.90
1917.			
Coal gas	42,927,728	38,324,113	.89
By-product gas	131,026,575	11,360,335	.09
Oil gas and water gas	168,196,826	145,346,976	.86
1918.			
Coal gas	42,659,487	42,846,964	1.00
By-product gas	158,358,479	13,699,515	.09
Oil gas and water gas	192,281,580	171,184,159	.89

Artificial gas consumed in the United States, 1912–1918, by uses, in thousand cubic feet

	Illuminating gas.	Fuel gas.	Total.
1912.			
Coal and by-product gas	31,864,052	57,829,320	89,693,372
Oil gas and water gas	68,136,269	54,561,527	122,697,796
	100,000,321	112,390,847	212,391,168
1915.			
Coal and by-product gas	31,541,485	96,561,861	128,103,346
Oil gas and water gas	49,255,388	88,845,514	138,100,902
	80,796,873	185,407,375	266,204,248
1917.			
Coal and by-product gas	32,590,673	141,363,630	173,954,303
Oil gas and water gas	47,553,976	120,642,850	168,196,826
	80,144,649	262,006,480	342,151,129
1918.			
Coal and by-product gas	(a)	(a)	201,017,966
Oil gas and water gas	(a)	(a)	192,281,580
	[a]234,874,890	[a]158,424,656	393,299,546

[a] The distribution of sales between illuminating gas and fuel gas was reported on for only 63 per cent of the total gas sold. Except for coke-oven gas the distribution figures therefore do not represent actual reports from operators but are based on the proportion shown by those operators who do report distribution.

Artificial gas consumed per capita in the United States, 1907–1918.

[Exclusive of by-product gas.]

Year.	Consumption.	Population.	Per capita consumption.
	Thousand cubic feet.		*Cubic feet.*
1907	128,937,576	87,320,539	1,477
1908	140,703,383	88,938,527	1,582
1912	157,899,920	95,410,503	1,655
1915	181,848,334	100,536,347	1,809
1917	211,124,554	103,640,473	2,037
1918	234,941,067	106,795,270	2,200

PRODUCTION.

Artificial gas and by-products marketed in the United States, 1917 and 1918.[a]

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Gas (M cubic feet):				
Coal gas	42,927,728	$38,324,113	42,659,487	$42,846,964
Water gas	153,457,318	131,876,065	192,281,580	171,184,159
Oil gas	14,739,508	13,470,911		
By-product gas	131,026,575	11,360,335	158,358,479	13,699,515
	342,151,129	195,031,424	393,299,546	227,730,638
Coke (short tons): [b]				
Coal gas	1,857,248	10,953,693	1,813,740	13,963,232
By-product	22,439,280	138,643,153	25,997,580	193,018,785
	24,296,528	149,596,846	27,811,320	206,982,017
Tar (gallons):				
Coal gas	53,318,413	1,774,326	47,727,839	1,863,580
Water gas	59,533,208	1,258,683	54,733,478	1,789,898
Oil gas	727,556	32,682	550,006	15,967
By-product	221,990,264	5,566,302	200,233,002	6,364,972
	335,578,441	8,631,993	303,244,325	10,034,417
Ammonium sulphate or equivalent (pounds):				
Coal gas	88,547,975	1,362,125	56,900,464	1,453,070
By-product	560,792,322	17,903,864	669,287,568	26,442,951
	649,340,297	19,265,989	726,188,032	27,896,021
Light oils (gallons): [c]				
Coal gas	770,298	448,855	12,347,288	6,992,987
Water gas	6,420,717	1,655,204		
Oil gas	205,475	74,035	20,376	4,274
By-product	54,387,266	28,655,204	59,564,376	25,688,446
	61,783,756	30,833,298	71,932,040	32,685,707
Naphthalene (pounds):				
Coal gas	399,897	9,687	896,080	14,282
Water gas				
By-product	17,276,044	569,449	15,890,447	650,229
	17,675,941	579,136	16,786,527	664,511
Retort carbon (short tons):				
Coal gas	252	2,733	1,007	13,275
Water gas	1,068	12,067	251	2,230
By-product	....	....	655	2,732
	1,320	14,800	1,913	18,237
Lampblack and carbon residue (short tons): [d]				
Oil gas	31,205	169,425	17,678	95,211

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[a] Other products not included in this table, valued at $807,147 in 1917, and $1,808,515 in 1918, were: From coal-gas plants, creosote, tar distillery products, pitch, coke breeze, and spent oxide; from oil-gas plants, yellow prussiate of soda; from by-product coke oven plants, coke breeze, sodium ferrocyanide, residue, drip oil, spent oxide, and pyridin oil.

[b] Figures for coal-gas coke represent sales only; those for by-product represent total production.

[c] Include crude light oil, secondary light oil, benzol, toluol, solvent naphtha, and drip oil.

[d] Exclusive of briquets made from carbon residue.

GAS (NATURAL).

PRODUCTION AND CONSUMPTION.

Natural gas produced and consumed in the United States, 1917 and 1918.

State.	Production.			Consumption.		
	Volume (M cubic feet).	Value.	Average price (cents per M cubic feet).	Volume (M cubic feet).	Value.	Average price (cents per M cubic feet).
1917.						
West Virginia	308,617,101	$57,389,161	18.60	[a] 115,488,192	$10,558,612	9.14
Oklahoma	137,384,154	13,984,656	10.18	[b] 122,177,676	10,900,827	8.92
Pennsylvania	133,397,206	28,716,492	21.53	202,259,498	40,773,689	20.16
Ohio	68,917,231	18,434,814	26.75	165,782,369	44,742,782	26.99
California	49,427,331	6,816,524	13.79	49,427,331	6,816,524	13.79
Louisiana	31,286,476	3,262,987	10.43	[c] 31,286,476	3,262,987	10.43
Kansas	24,438,848	5,701,436	23.33	[d] 37,962,857	8,463,767	22.29
Texas	17,047,292	3,192,625	18.73	17,901,637	3,433,123	19.18
New York	8,371,747	2,499,303	29.85	22,466,848	6,912,540	30.77
Arkansas	5,609,484	315,612	5.63	[e] 6,437,608	396,612	6.16
Illinois	4,439,016	479,072	10.79	[f] 4,439,016	479,072	10.79
Kentucky	2,802,079	580,380	20.71	12,053,445	3,114,402	25.84
Indiana	1,711,454	453,310	26.49	5,766,466	1,971,435	34.19
Wyoming	1,223,136	144,425	11.81	1,223,136	144,425	11.81
Colorado						
Montana	334,421	81,406	24.34	334,421	81,406	24.34
South Dakota	59,666	25,213	42.26	59,666	25,213	42.26
Alabama						
North Dakota						
Missouri	31,425	8,230	26.19	31,425	8,230	26.19
Tennessee	10,900	2,450	22.48	10,900	2,450	22.48
Michigan	1,184	1,013	85.55	1,184	1,013	85.55
Iowa	225	225	100.00	225	225	100.00
	795,110,376	142,089,334	17.87	795,110,376	142,089,334	17.87
1918.						
West Virginia	265,160,917	41,324,365	15.58	108,673,444	12,284,789	11.30
Oklahoma	124,317,179	15,805,135	12.71	106,661,404	12,724,364	11.92
Pennsylvania	123,813,358	38,608,883	31.18	177,139,804	44,777,220	25.27
Ohio	61,261,069	24,234,741	39.55	143,585,260	43,694,161	30.43
California	39,718,941	7,951,666	20.01	39,718,941	7,951,666	20.01
Louisiana	36,094,132	4,912,235	13.60	26,324,150	2,597,035	9.86
Kansas	27,824,641	6,640,781	23.86	33,912,283	7,064,218	20.83
Texas	13,439,624	5,027,449	37.40	20,282,713	5,518,462	27.20
New York	8,460,583	5,673,131	67.05	20,341,207	6,779,207	33.32
Arkansas	5,294,663	575,115	10.86	12,229,288	1,971,100	16.11
Illinois	4,473,018	620,949	13.88	4,473,018	620,949	13.88
Wyoming	4,338,840	156,171	3.59	4,338,840	156,171	3.59
Kentucky	3,022,439	665,843	22.03	12,200,190	3,093,393	25.35
Tennessee	1,826,725	361,140	19.76	1,826,725	361,140	19.76
Indiana	1,666,822	899,671	53.97	4,516,583	1,510,404	33.44
Montana	177,039	62,148	35.10	177,039	62,148	35.10
South Dakota	42,186	19,109	45.29	42,186	19,109	45.29
Utah	25,916	2,700	10.41	25,916	2,700	10.41
Washington						
Maryland						
Missouri	22,120	5,548	25.08	4,511,221	2,358,544	52.28
Colorado	10,103	2,575	25.48	10,103	2,575	25.48
Alabama	4,600	1,890	41.08	4,600	1,890	41.08
Oregon	2,200	550	25.00	2,200	550	25.00
Iowa	1,758	245	13.93	1,758	245	13.93
Michigan	1,173	1,045	89.08	1,173	1,045	89.08
North Dakota	913	475	52.02	913	475	52.02
	721,000,959	153,553,560	21.29	721,000,959	153,553,560	21.29

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[a] Includes gas piped from West Virginia and consumed in Maryland.
[b] Includes gas piped from Oklahoma and consumed in Missouri.
[c] Includes gas piped from Louisiana and consumed in Arkansas and Texas.
[d] Includes gas piped from Kansas and consumed in Missouri.
[e] Includes gas piped from Oklahoma.
[f] Includes gas piped from Illinois and consumed in Indiana.

GASOLINE FROM NATURAL GAS.

PRODUCTION.

Natural-gas gasoline produced in the United States in 1917 and 1918.

State.	Number of operators.[a]	Number of plants.	Gasoline produced.			Gas used.	
			Quantity (gallons).	Value.	Average price per gallon (cents).	Estimated volume (M cubic ft.).	Average yield of gasoline per thousand cubic feet (gallons).
1917.							
Oklahoma	167	234	115,123,424	$21,541,905	18.71	84,719,941	1.359
West Virginia	128	188	32,668,647	6,511,813	19.93	167,771,351	.195
California	45	49	28,817,604	4,438,022	15.40	45,351,247	.635
Pennsylvania	287	251	13,826,250	2,778,098	20.01	49,487,056	.279
Texas	10	11	6,920,405	1,149,441	16.61	12,677,216	.546
Ohio	49	61	5,439,560	1,051,376	19.33	30,062,141	.181
Louisiana	15	20	4,979,754	814,747	16.36	2,233,511	2.229
Illinois	33	55	4,934,009	866,033	17.55	2,685,895	1.837
Kentucky	5	5	3,818,209	763,186	19.99	24,915,946	.153
Kansas	4	6	1,174,980	241,219	20.53	9,315,339	.126
New York Colorado	7	6	181,262	33,116	18.27	68,154	2.659
	750	886	217,884,104	40,188,956	18.45	429,287,797	.508
1918.							
Oklahoma	133	276	163,700,550	28,389,045	17.3	78,322,307	2.09
West Virginia	79	208	37,603,903	7,498,804	19.9	163,929,550	.23
California	29	56	32,268,933	5,009,152	15.5	50,490,019	.64
Pennsylvania	200	282	15,775,058	3,249,233	20.6	56,982,063	.28
Texas	8	13	7,326,122	1,214,565	16.6	8,493,182	.86
Louisiana	9	18	7,020,538	1,178,651	16.8	13,462,317	.52
Ohio	36	55	6,744,907	1,355,447	20.1	37,739,322	.18
Illinois	34	72	4,574,565	890,436	19.5	2,316,646	1.97
Kentucky	5	6	3,330,986	660,108	19.8	19,816,518	.17
Kansas	5	11	2,389,856	593,730	24.8	16,023,067	.15
Wyoming	2	3	1,579,526	268,339	17.0	1,433,564	1.10
New York	5	4	218,131	55,405	25.4	99,487	2.19
Colorado			2,475	620	25.1	619	4.00
	[a] 503	1,004	282,535,550	50,363,535	17.8	449,108,661	.63

[a] Irrespective in 1918 of the kind, number, and location of the plants operated. The sum of the number of operators listed for each State will not give the actual number of operators in the United States, so that the figures for 1918 are not comparable with those for earlier years.

GEMS AND PRECIOUS STONES.

PRODUCTION.

Value of precious stones produced in the United States, 1913–1918.

Variety.	1913	1914	1915	1916	1917	1918
Beryl	$1,615	$2,395	$1,675	$2,031	$2,178	$1,906
Copper ore gems	2,350	1,280	1,120	1,713	2,857	2,299
Corundum	238,835	61,032	88,214	99,180	54,204	42,414
Diamond	6,315	765	608	2,680	4,175	1,910
Feldspar	1,285	449	368	305	(a)	(a)
Garnet	4,285	1,760	4,523	1,542	624	1,277
Hematite	....	....	126	(a)	(a)	138
Jade	....	300	....	....	....	....
Opal	15,130	1,114	1,850	1,838	805	6,304
Peridot	375	100	(a)	455	(a)	1,018
Pyrite	50	....	1,042	2,075	(a)	(a)
Quartz	16,861	18,838	35,724	25,707	28,273	15,211
Rhodonite	165	1,050	85	(a)	(a)	515

[a] Small production included under "Miscellaneous gems."

Value of precious stones produced in the United States, 1913–1918—Continued.

Variety.	1913	1914	1915	1916	1917	1918
Smithsonite	$50	$50	(a)	....	(a)	....
Spodumene	6,520	4,000	(a)	(a)	(a)	$281
Thomsonite	....	21	(a)	$47	(a)	(a)
Topaz	736	1,380	$862	1,005	$230	907
Tourmaline	7,680	7,980	10,969	50,807	12,452	6,206
Turquoise	8,075	13,370	11,691	21,811	14,171	20,667
Variscite	6,105	5,055	3,867	3,140	2,350	753
Vesuvianite	152	1,425	1,535	(a)	2,765	320
Miscellaneous gems	2,920	2,287	6,172	3,457	5,928	4,397
	319,454	124,651	170,431	217,793	131,012	106,523

[a] Small production included under "Miscellaneous gems."

IMPORTS.

Diamonds and other precious stones imported and entered for consumption in the United States, 1913–1918.

Year.	Diamonds.				Other stones not set.	Total, excluding pearls.	Pearls.
	Glazier's.	Dust and bort.	Rough or uncut.	Cut but not set.			
1913	$471,712	$100,704	$12,268,543	$24,812,604	$2,805,963	$40,459,526	$5,002,624
1914	579,332	77,408	2,851,933	11,976,871	1,649,875	17,135,419	2,090,018
1915	366,793	75,944	7,020,646	13,177,919	1,078,391	21,719,693	4,513,909
1916	836,018	67,290	11,441,328	24,282,140	2,303,351	38,930,127	11,336,971
1917	1,098,102	349,746	13,092,855	18,421,838	1,883,810	34,846,351	4,947,509
1918	718,397	475,870	12,636,024	7,734,150	1,102,398	22,666,839	765,929

EXPORTS.

No domestic exports are recorded.

Foreign precious stones reexported, 1913–1918.

Year.	Diamonds.			Other precious stones.		Total, excluding pearls.	Pearls and parts of, not strung or set.
	Uncut.	Cut but not set.	Bort.	Uncut.	Cut but not set.		
1913	$1,870	$57,117	(a)	$1,707	$7,239	$67,933	$24,787
1914	14,809	20,350	(a)	2,573	53,086	90,818	1,066
1915	97,764	5,119	$2,470	661	10,554	116,568	116,809
1916	6,979	9,342	4	9,023	48,352	73,700	894,115
1917	7,757	400	14,962	1,512	16,842	41,473	20,353
1918	[b] 100	....	56	....	57	213	42,908

[a] Not shown for this year.

[b] Includes some bort.

GOLD AND SILVER.

PRODUCTION.

Gold and silver produced in the United States in 1918, with increase or decrease as compared with 1917.

State.	Gold.		Silver.		Gold.	Silver.	
						Increase or decrease.	
	Quantity (troy ounces).	Value.[a]	Quantity (troy ounces).	Value.[a]	Increase or decrease.	Quantity (troy ounces).	Value.
Alabama	34	$700	2	$2	− $1,500	+ 2	+ $2
Alaska	455,920	9,424,700	802,743	787,057	− 5,246,700	− 404,421	− 207,043
Arizona	270,078	5,583,000	6,831,465	6,697,978	+ 402,400	− 130,792	+ 964,578
California	811,945	16,784,400	1,432,812	1,404,815	− 4,145,000	− 674,295	− 330,385
Colorado	615,558	12,724,700	6,900,266	6,765,435	− 3,249,800	− 391,229	+ 760,935
Georgia	218	4,500	45	44	− 2,000	+ 45	+ 44
Idaho	33,930	701,400	9,396,009	9,212,411	− 53,400	−2,006,533	− 177,589
Illinois	....	....	8,218	8,057	....	+ 1,102	+ 2,157
Maine	34	700	6,338	6,214	+ 700	+ 6,338	+ 6,214
Maryland	....	....	164	161	....	− 374	− 239
Michigan	....	....	516,294	506,206	....	− 167,931	− 57,194
Missouri	3	60	42,214	41,389	− 240	− 21,130	− 10,811
Montana	158,704	3,280,700	16,378,263	16,058,232	− 392,500	+1,823,229	+4,072,132
Nevada	324,134	6,700,440	9,931,969	9,737,898	− 232,060	−1,285,685	+ 500,198
New Hampshire	....	....	691	678	....	+ 691	+ 678
New Mexico	33,237	687,080	773,662	758,545	− 398,320	− 762,145	− 506,155
North Carolina	213	4,400	100	98	− 6,400	− 490	− 402
Oregon	61,228	1,265,700	129,150	126,626	− 421,600	− 43,002	− 15,174
Philippine Islands	62,404	1,290,000	13,000	12,746	− 156,100	+ 285	+ 2,246
Porto Rico	5	100	....	....	....	....	....
South Carolina	....	....		....	− 1,700	....	....
South Dakota	324,083	6,699,400	161,232	158,082	− 673,500	− 29,150	+ 1,282
Tennessee	271	5,600	105,829	103,761	+ 100	− 1,146	+ 15,661
Texas	1	20	579,158	567,841	− 80	− 8,787	+ 83,641
Utah	152,526	3,153,000	13,492,555	13,228,911	− 369,100	+ 131,650	+2,226,211
Vermont	48	1,000	4,891	4,795	+ 900	+ 4,488	+ 4,495
Virginia	19	400	1,814	1,779	− 900	− 2,686	− 1,921
Washington	16,148	333,800	300,000	294,138	− 154,400	+ 33,888	+ 75,038
Wyoming	43	900	1,255	1,230	− 2,800	− 2,145	− 1,570
	3,320,784	68,646,700	67,810,139	66,485,129	−15,104,000	−3,930,223	+7,407,029

[a] Gold value $20.67+ per troy ounce. Average commercial (dealers') buying price of silver 0.999 fine in 1918, $0.98046 per troy ounce.

Gold and silver produced in the United States. 1913–1918.

Year.	Gold.		Silver.	
	Quantity (troy ounces).	Value.	Quantity (troy ounces).	Commercial value.
1913	4,299,783	$88,884,400	66,801,500	$40,348,100
1914	4,572,976	94,531,800	72,455,100	40,067,700
1915	4,887,602	101,035,700	74,961,075	37,397,300
1916	4,479,056	92,590,300	74,414,802	48,953,000
1917	4,051,440	83,750,700	71,740,362	59,078,100
1918	3,320,784	68,646,700	67,810,139	66,485,129

According to tables published by the Director of the Mint the total production of gold and silver in the United States is as follows:

Gold and silver produced in the United States, 1792-1918.

[The estimate for 1792-1872 is by R. W. Raymond, commissioner, and for the period since 1872 by the Director of the Mint.]

Period.	Gold.		Silver.	
	Quantity. (troy ounces).	Value.	Quantity (troy ounces).	Commercial value.
1792-1847	1,187,170	$24,537,000	309,500	$404,500
1848-1872	58,279,778	1,204,750,000	118,568,200	157,749,900
1873-1918	133,131,361	2,752,067,600	2,328,469,878	1,803,344,429
	192,598,309	3,981,354,600	2,447,347,578	1,961,498,829

IMPORTS AND EXPORTS.

Value of gold and silver imported and exported, 1917 and 1918.

1917.

	Imports.	Exports.	Excess of—	
			Imports.	Exports.
GOLD.				
Contained in domestic ore and base bullion		$251,963		$251,963
Contained in foreign ore and base bullion	$15,508,581		$15,508,581	
Domestic bullion refined		90,212,645		90,212,645
Foreign bullion refined	401,687,827	31,470	401,656,357	
United States coin	62,312,573	274,036,206		211,723,633
Foreign coin	72,945,393	7,351,600	65,593,793	
	552,454,374	371,883,884	482,758,731	302,188,241
Excess			180,570,490	
SILVER.				
Contained in domestic ore and base bullion		167,326		167,326
Contained in foreign ore and base bullion	37,668,562		37,668,562	
Domestic bullion refined		76,555,369		76,555,369
Foreign bullion refined	9,497,753	3,214,819	6,282,934	
United States coin	1,162,009	1,003,379	158,630	
Foreign coin	5,012,153	3,189,983	1,822,170	
	53,340,477	84,130,876	45,932,296	76,722,695
Excess				30,790,399

1918.

GOLD.				
Contained in domestic ore and base bullion		$206,674		$206,674
Contained in foreign ore and base bullion	$16,251,930		$16,251,930	
Domestic bullion refined		8,052,578		8,052,578
Foreign bullion refined	38,911,037		38,911,037	
United States coin	6,743,464	32,431,889		25,688,425
Foreign coin	136,317	378,677		242,360
	62,042,748	41,069,818	55,162,967	34,190,037
Excess			20,972,930	
SILVER.				
Contained in domestic ore and base bullion		18,248		18,248
Contained in foreign ore and base bullion	44,877,920		44,877,920	
Domestic bullion refined		236,411,329		236,411,329
Foreign bullion refined	20,619,195	6,016,337	14,602,858	
United States coin	1,267,837	3,542,926		2,275,089
Foreign coin	4,610,747	6,857,624		2,246,877
	71,375,699	252,846,464	59,480,778	240,951,543
Excess				181,470,765

PRICES.

Gold is valued by law at $20.67+a troy ounce.
For prices of silver, see statement on page 26A.

GRAPHITE.

PRODUCTION.

Crystalline graphite sold in the United States, 1917 and 1918, by States.

State.	1917		1918	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Alabama	6,223,095	$719,575	7,795,475	$999,152
New York	2,941,040	261,548	3,266,518	273,188
Pennsylvania	804,945	77,475	1,016,900	112,059
Other States [a]	615,000	35,800	782,946	70,400
	10,584,080	1,094,398	12,861,839	1,454,799

[a] 1917: Alaska, California, Montana, and Texas; 1918: California, Montana, and Texas.

The sales of amorphous graphite during 1918 amounted to 6,560 tons, valued at $69,455, as compared with 8,301 tons, valued at $73,481, in 1917.

Domestic natural graphite sold, 1913–1918.

Year.	Amorphous.		Crystalline.		Total.	
	Quantity (short tons).	Value.	Quantity (pounds).	Value.	Quantity (short tons).	Value.
1913	2,243	$39,428	5,064,727	$254,328	4,775	$293,756
1914	1,725	38,750	5,220,539	285,368	4,335	324,118
1915	1,181	12,358	7,074,370	417,273	4,718	429,631
1916	2,622	20,723	10,931,989	914,748	8,088	935,471
1917	8,301	73,481	10,584,080	1,094,398	13,593	1,167,879
1918	6,560	69,455	12,861,839	1,454,799	12,991	1,524,254

IMPORTS.

Graphite imported for consumption in the United States, 1913–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1913	28,879	$2,109,791	1916	42,960	$7,279,884
1914	21,990	1,398,209	1917	42,577	8,961,988
1915	23,075	2,241,163	1918	19,498	3,092,475

EXPORTS.

Exports of graphite, 1913–1918.

Year.	Unmanufactured graphite.		Manufactures of graphite.
	Quantity (pounds).	Value.	
1913	5,383,981	$391,906	$238,302
1914	3,920,693	277,386	215,878
1915	1,057,764	52,583	536,572
1916	1,595,608	98,118	1,339,259
1917	5,146,816	349,563	891,687
1918	1,907,719	121,555	731,518

PRICES.

Prices of best grades of domestic flake graphite (sales at mines) and Ceylon lump (New York prices), in cents per pound, 1911–1918.

Year.	Domestic flake.	Ceylon lump.	Year.	Domestic flake.	Ceylon lump.
1911	6 -7	8½- 9	1915	7-10	9¾-20
1912	6 -7	8½-10	1916	10-16	20 -28
1913	6 -8	9½-11	1917	12-18	28 -32
1914	6½-8	6½- 9½	1918	10-17¾	15½-28½

GRINDSTONES AND PULPSTONES.

[See under Abrasive materials.]

GYPSUM.

PRODUCTION.

Gypsum produced in the United States, 1909–1918.

Year.	Crude (short tons).	Crude and calcined (total value).	Year.	Crude (short tons).	Crude and calcined (total value).
1909	2,252,785	$5,906,738	1914	2,476,465	$6,895,989
1910	2,379,057	6,523,029	1915	2,447,611	6,596,893
1911	2,323,970	6,462,035	1916	2,757,730	7,959,032
1912	2,500,757	6,563,908	1917	2,696,226	11,116,452
1913	2,599,508	6,774,822	1918	2,057,015	11,470,854

IMPORTS.

Gypsum imported into the United States comes almost wholly from Nova Scotia and New Brunswick and enters the ports of New England and other North Atlantic States.

Gypsum imported and entered for consumption in the United States, 1913–1918.

Year.	Unground.		Ground or calcined.		Value of manufactured plaster of Paris.	Keenes cement.		Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.		Quantity (short tons).	Value.	
1913	447,383	$473,594	4,542	$31,277	$52,051	1,851	$26,185	$583,107
1914	369,214	392,118	3,559	27,931	24,792	1,007	17,511	462,352
1915	336,856	356,791	5,749	22,873	10,095	427	6,656	396,415
1916	254,131	275,043	11,706	72,345	9,085	600	9,890	366,363
1917	240,269	265,504	16,533	109,732	6,016	484	8,003	389,255
1918	50,653	55,004	6,117	70,028	1,765	111	2,259	129,056

EXPORTS.

Exports of plaster of Paris in 1916 were valued at $13,076, and in the first six months of 1917 at $20,153. Data are not available for any other period.

IRON ORE,[1] PIG IRON, AND STEEL.

PRODUCTION OF IRON ORE.

Iron ore mined in the United States, by mining districts and varieties, in 1917 and 1918, in long tons.

1917.

District.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.
Lake Superior [a]	63,481,321				63,481,321
Birmingham	5,728,862	458,211			6,187,073
Chattanooga	524,787	296,698			821,485
Adirondack			1,100,001		1,100,001
Northern New Jersey and southeastern New York		(b)	[b] 642,232		642,232
Other districts	1,008,543	1,235,936	812,260		3,056,739
	70,743,513	1,992,332	2,553,006		75,288,851

1918.

District.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.	Percentage of change in 1918.
Lake Superior [a]	59,779,794				59,779,794	− 5.8
Birmingham	4,763,057	344,332			5,107,389	−17.5
Chattanooga	516,259	309,268			825,527	+ .5
Adirondack			762,029		762,029	−30.7
Northern New Jersey and southeastern New York			523,862		523,862	−18.4
Other districts	835,599	960,244	863,834		2,659,677	−13.0
	65,894,709	1,613,844	2,149,725		69,658,278	− 7.5

[a] Includes only those mines in Wisconsin which are in the true Lake Superior district.
[b] A small quantity of brown ore included in magnetite.

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[1] Exclusive of all domestic ore containing 5 per cent or more of manganese. For data regarding such ore see under Manganese.

Iron ore mined in the United States, by varieties, 1913–1918, in long tons.

Year.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.
1913	57,933,251	1,682,063	2,357,274	7,849	61,980,437
1914	38,286,670	1,537,750	1,610,203	5,138	41,439,761
1915	52,227,324	1,488,709	1,807,002	3,455	55,526,490
1916	70,728,024	1,904,484	2,533,364	1,800	75,167,672
1917	70,743,513	1,992,332	2,553,006	....	75,288,851
1918	65,894,709	1,613,844	2,149,725	....	69,658,278

Iron ore produced in the Lake Superior district, by ranges, 1913–1918, in long tons.

Year.	Marquette.	Menominee.	Gogebic.	Vermilion.	Mesabi.	Cuyuna.	Total.
1913	3,977,808	4,997,246	4,743,515	1,536,115	36,378,671	744,007	52,377,362
1914	3,320,763	3,671,499	4,601,240	1,362,416	19,808,434	776,051	33,540,403
1915	3,817,892	4,665,465	4,996,237	1,541,645	30,802,409	1,120,606	46,944,254
1916	4,792,987	6,649,578	7,707,101	1,704,440	41,325,841	1,555,641	63,735,088
1917	4,638,374	6,366,483	7,881,232	1,481,301	41,127,323	1,986,608	63,481,321
1918	3,946,554	6,041,637	7,837,634	1,192,677	39,055,977	1,706,315	59,779,794

SHIPMENTS OF IRON ORE.

Iron ore shipped from mines in the United States, 1917 and 1918, by States.

State.	1917		1918		Increase or decrease in 1918.		Percentage of increase or decrease in 1918.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity.	Value.
Alabama	7,101,586	$13,049,535	6,121,067	$15,334,561	− 980,499	+$2,285,026	− 13.8	+ 17.5
California	2,207	8,828	3,121	14,683	+ 914	+ 5,855	+ 41.4	+ 66.3
Georgia	211,501	524,175	262,003	878,612	+ 50,502	+ 354,437	+ 23.9	+ 67.6
Maryland	10,730	40,423	6,070	23,686	− 4,660	− 16,737	− 43.4	− 41.4
Michigan	17,712,916	62,833,624	17,587,416	65,900,501	− 125,500	+ 3,066,877	− .7	+ 4.9
Minnesota	44,962,127	142,901,148	43,263,240	144,706,532	−1,698,887	+ 1,805,384	− 3.8	+ 1.3
Missouri	38,770	134,906	71,968	270,337	+ 33,198	+ 135,431	+ 85.6	+100.4
New Jersey	474,708	2,341,160	375,238	1,945,651	− 99,470	− 395,509	− 21.0	− 16.9
New Mexico	231,604	381,275	275,266	546,212	+ 43,662	+ 164,937	+ 18.9	+ 43.3
New York	1,356,011	7,381,333	899,970	5,802,870	− 456,041	− 1,578,463	− 33.6	− 21.4
North Carolina	90,957	445,898	108,332	604,592	+ 17,375	+ 158,694	+ 19.1	+ 35.6
Pennsylvania	548,674	873,520	515,845	982,173	− 32,829	+ 108,853	− 6.0	+ 12.5
Tennessee	520,460	1,235,718	408,954	1,184,546	− 111,506	− 51,172	− 21.4	− 4.1
Utah	([a])	([a])	52,722	168,438	([b])	([b])	([b])	([b])
Virginia	472,337	1,182,449	400,135	1,365,582	− 72,202	+ 183,133	− 15.3	+ 15.5
Wisconsin	1,179,709	3,913,437	1,167,640	3,796,408	− 12,069	− 117,029	− 1.0	− 3.0
Other States [c]	658,910	1,013,215	502,195	842,763	− [b] 103,993	− [b] 2,014	−[b]15.8	− [b].2
	75,573,207	238,260,444	72,021,202	244,368,147	−3,552,005	+ 6,107,703	− 4.7	+ 2.6

[a] Less than three shippers in Utah in 1917 and permission not granted to publish State total. Figures for this State, therefore, included in "Other States."

[b] Increase for Utah included with those for "Other States."

[c] 1917: Arkansas, Colorado, Connecticut, Iowa, Massachusetts, Montana, Nevada, Utah, West Virginia, and Wyoming; 1918: Colorado, Connecticut, Idaho, Massachusetts, Montana, Nevada, Texas, Washington, and Wyoming.

STOCKS OF IRON ORE.

Stock of iron ore at mines, by States, Dec. 31, 1917 and 1918, in long tons.

State.	1917	1918	State.	1917	1918
Alabama	617,222	242,781	New Mexico	7,700	1,100
California	14	....	New York	61,647	35,049
Georgia	20,654	20,025	North Carolina	40	40
Iowa	5,113	12,165	Ohio	3,388	3,388
Maryland	2,130	4,141	Pennsylvania	34,961	41,593
Massachusetts	2,950	1,172	Virginia	30,613	44,527
Michigan	4,946,986	4,258,920	Wisconsin	310,557	232,250
Minnesota	4,802,634	3,365,540			
Missouri	2,320	3,060		11,003,843	8,471,507
New Jersey	154,914	205,756			

IMPORTS AND EXPORTS OF IRON ORE.

Iron ore imported into and exported from the United States, 1913–1918.

Year.	Imports.		Exports.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1913	2,594,770	$8,336,819	1,042,151	$3,513,419
1914	1,350,588	4,483,832	551,618	1,794,193
1915	1,341,281	4,181,645	707,641	2,181,629
1916	1,325,736	4,566,514	1,183,952	3,702,496
1917	971,663	3,655,392	1,132,313	4,464,111
1918	787,468	3,464,304	1,256,383	5,535,090

PRICES OF IRON ORE.

Average price of iron ore per long ton at the mines in the United States, 1913–1918.

Year.	Hematite.	Brown ore.	Magnetite.	Carbonate.	General average.
1913	$2.21	$1.88	$2.07	$2.06	$2.19
1914	1.79	1.72	2.39	2.44	1.81
1915	1.80	1.80	2.50	2.44	1.83
1916	2.32	2.03	3.11	3.00	2.34
1917	3.12	2.95	4.29	....	3.15
1918	3.35	3.51	4.60	....	3.39

Selling prices of iron ore per long ton at lower Lake ports at date of buying movement, 1913–1918.[a]

Season.	Date of buying movement.	Season iron-ore prices.			
		Old range Bessemer.	Mesabi Bessemer.	Old range non-Bessemer.	Mesabi non-Bessemer.
1913	Nov. 19, 1912	$4.40	$4.15	$3.60	$3.40
1914	May 1, 1914	3.75	3.50	3.00	2.85
1915	Apr. 19, 1915	3.75	3.45	3.00	2.80
1916	Dec. 7, 1915	4.45	4.20	3.70	3.55
1917	Nov. 22, 1916	5.95	5.70	5.20	5.05
1918 [b]	Apr. 1, 1918	5.95	5.70	5.20	5.05
	July 1, 1918	6.40	6.15	5.65	5.50
	Oct. 1, 1918	6.65	6.40	5.90	5.75

[a] Iron Trade Review.

[b] Prices approved by the Government Apr. 1 were advanced 45 cents for all grades on July 1, and 25 cents on Oct. 1.

PRODUCTION OF PIG IRON.

Pig iron shipped from blast furnaces in the United States in 1917 and 1918.

State.	1917		1918		Change in 1918.		Percentage of change, 1918.	
	Quantity (long tons.)	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity.	Value.
Alabama	2,971,626	$64,309,714	2,645,179	$80,893,687	− 326,447	+$16,583,973	− 11.0	+ 25.8
Illinois	3,458,126	91,094,541	3,409,876	105,415,030	− 48,250	+ 14,320,489	− 1.4	+ 15.7
Indiana	(a)	(a)	2,583,375	75,149,991	(b)	(b)	(b)	(b)
Kentucky	192,204	5,532,367	234,952	8,031,994	+ 42,748	+ 2,499,627	+ 22.2	+ 45.2
Michigan	611,446	18,300,501	502,884	17,823,684	− 108,562	− 476,817	− 17.8	− 2.6
Missouri	(a)	(a)	83,432	3,084,136	(b)	(b)	(b)	(b)
New Jersey	187,753	6,618,536	222,418	7,611,885	+ 34,665	+ 993,349	+ 18.5	+ 15.0
New York	2,276,367	52,318,661	2,482,450	70,167,542	+ 206,083	+ 17,848,881	+ 9.1	+ 34.1
Ohio	8,469,052	231,165,093	8,711,205	263,189,621	+ 242,153	+ 32,024,528	+ 2.9	+ 13.9
Pennsylvania	15,423,262	460,677,474	14,701,252	465,859,029	− 722,010	+ 5,181,555	− 4.7	+ 1.1
Tennessee	346,638	9,102,441	342,538	11,672,606	− 4,100	+ 2,570,165	− 1.2	+ 28.2
Virginia	562,299	15,703,295	453,863	15,430,473	− 108,436	− 272,822	− 19.3	− 1.7
Wisconsin	402,732	11,032,274	363,225	13,832,908	− 39,507	+ 2,800,634	− 9.8	+ 25.4
Other States[c]	3,711,041	87,931,078	1,493,791	42,596,979	+[b]449,557	+[b]32,900,028	+[b]12.1	+[b]37.4
	38,612,546	1,053,785,975	38,230,440	1,180,759,565	− 382,106	+126,973,590	− 1.0	+ 12.0

[a] Included in "Other States."
[b] Increases in Indiana and Missouri included in "Other States."
[c] 1917: Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, Washington, and West Virginia; 1918: Colorado, Connecticut, Georgia, Maryland, Massachusetts, Minnesota, Washington, and West Virginia.

Pig-iron shipments from blast furnaces in the United States, 1910–1918.[a]

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1910	[a] 26,674,123	[a] $412,162,486	1915	30,384,486	$401,409,604
1911	23,257,288	327,334,624	1916	39,126,324	663,478,118
1912	30,180,969	420,563,388	1917	38,612,546	1,053,785,975
1913	30,388,935	458,342,345	1918	38,230,440	1,180,759,565
1914	22,263,263	298,777,429			

[a] Includes ferroalloys in 1910 only.

IMPORTS OF PIG IRON.

Pig iron, including kentledge, ferromanganese, ferrosilicon, and spiegeleisen, imported into the United States, 1913–1918.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1913	156,450	$6,557,095	1916	135,349	$10,239,868
1914	138,903	4,694,186	1917	76,786	7,872,105
1915	89,836	4,108,180	1918	34,711	4,968,056

EXPORTS OF PIG IRON.

Pig iron exported from the United States to foreign countries, 1913–1918.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1913	277,648	$4,026,306	1916	607,236	$15,381,431
1914	114,423	1,638,102	1917	656,220	24,037,051
1915	224,509	3,667,167	1918	269,575	11,576,721

PRODUCTION OF STEEL.

Steel produced in the United States, 1909–1918, in long tons.[a]

Year.	Bessemer.	Open-hearth.	Crucible.	Other steel.	Total.
1909	9,330,783	14,493,936	107,355	22,947	23,955,021
1910	9,412,772	16,504,509	122,303	55,335	26,094,919
1911	7,947,854	15,598,650	97,653	31,949	23,676,106
1912	10,327,901	20,780,723	121,517	21,162	31,251,303
1913	9,545,706	21,599,931	121,226	34,011	31,300,874
1914	6,220,846	17,174,684	89,869	27,631	23,513,030
1915	8,287,213	23,679,102	113,782	70,939	32,151,036
1916	11,059,039	31,415,427	129,692	169,522	42,773,680
1917	10,479,960	34,148,893	126,716	305,038	45,060,607
1918	9,376,236	34,459,391	115,112	511,693	44,462,432

[a] According to the American Iron and Steel Institute.

LEAD.

SUPPLY.

Apparent consumption of refined primary lead in the United States (refinery stocks disregarded), 1914–1918, in short tons.

	1914	1915	1916	1917	1918
Supply:					
Stock in bonded warehouses Jan. 1	....	2	....	535	2,685
Imports of pigs, bars, and old	148	410	5,655	5,793	5,240
Production	542,122	550,055	571,134	610,769	640,195
	542,270	550,467	576,789	617,097	648,120
Withdrawn:					
Exports of foreign lead—					
From warehouse	21,545	38,618	9,880	37,652	59,416
In manufactures, with benefit of drawback	9,489	3,983	5,171	7,537	3,426
Exports of domestic lead	58,722	88,306	100,500	53,688	41,831
Stock in bonded warehouses Dec. 31	2	....	535	2,685	472
	89,758	130,907	116,086	101,562	105,145
Apparent consumption	452,512	419,560	460,703	515,535	542,975

PRODUCTION.

REFINED LEAD.

Refined primary lead produced in the United States, 1913–1918, in short tons.

	1913	1914	1915	1916	1917	1918
Domestic ore:						
Desilverized lead	250,578	311,069	301,564	316,469	303,679	282,024
Soft lead	131,867	158,219	161,461	167,515	188,503	210,463
Desilverized soft lead	29,433	43,506	44,001	68,244	56,268	47,418
Total from domestic ore	411,878	512,794	507,026	552,228	548,450	539,905
Foreign ore:						
Africa	5,976	2,942	....	328	1,738	1,519
Australia	....	....	....	....	....	282
Canada	16	2	1,174	1,231	1,100	7,550
Central America	....	....	1	7	....	....
Mexico	4,512	2,386	5,437	1,917	7,607	4,798
South America	2,617	1,821	2,829	2,366	1,533	1,101
Other foreign	102	488	140	236	3,894	84
Foreign base bullion:						
Canada	....	....	....	1,072	6,750	8,108
Mexico	37,359	21,689	33,173	11,598	39,508	76,809
South America	....	....	275	151	189	39
Total from foreign ore and base bullion	50,582	29,328	43,029	18,906	62,319	100,290
Grand total from all sources	462,460	542,122	550,055	571,134	610,769	640,195
Production of antimonial lead	16,665	16,667	23,224	24,038	18,646	18,570

Refined primary lead produced in the United States from domestic ores, 1909–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1909	352,839	$30,344,154	1914	512,794	$39,998,000
1910	375,402	33,035,376	1915	507,026	47,660,000
1911	391,995	35,279,550	1916	552,228	76,207,000
1912	392,517	35,326,530	1917	548,450	94,333,000
1913	411,878	36,245,264	1918	539,905	76,667,000

SECONDARY LEAD.

Secondary lead produced in the United States, 1913–1918, in short tons.

	1913	1914	1915	1916	1917	1918
Pig lead	33,104	29,337	36,400	56,700	45,100	41,146
Lead in alloys	39,730	31,725	42,500	39,600	48,400	55,954
Total recovered lead	72,834	61,062	78,900	96,300	93,500	97,100

IMPORTS.

Lead imported into the United States in ore, base bullion, and refined, by countries, 1913—1918, in pounds.

[General imports.]

Country.	1913	1914	1915	1916	1917	1918
United Kingdom	404,594	245,548	185,236	261,406	8,689,992	56,710
Germany	262,132	4,529,919	....	....	....	....
Other European countries	143,293	123,085	32,537	314,353	255,907	5,800
Total from Europe	810,019	4,898,552	217,773	575,759	8,945,899	62,510
Canada	338,569	384,007	2,303,170	12,606,216	11,738,379	28,225,878
Mexico	95,693,439	46,282,207	94,247,384	48,395,670	125,782,759	162,259,199
South America	8,766,327	2,417,744	5,420,567	6,235,758	4,556,460	1,962,124
Other countries	8,685,612	2,694,293	802,516	2,845,949	5,520,323	4,705,049
Total imports	114,293,966	56,676,803	102,991,410	70,659,352	156,543,820	197,214,760

Lead imported into the United States, by classes, 1913–1918, in pounds.

[General imports.]

Year.	Lead in ore (lead content).	Base bullion.		Pigs, bars, sheets, and old.	Total lead content.
		Gross weight.	Lead content.		
1913	19,883,313	96,908,170	94,327,654	82,999	114,293,966
1914	23,649,637	33,444,503	32,730,320	296,846	56,676,803
1915	18,185,140	86,247,995	83,986,988	819,282	102,991,410
1916	35,086,100	24,943,660	24,262,435	11,310,817	70,659,352
1917	41,292,876	109,279,997	103,664,970	11,585,974	156,543,820
1918	37,070,340	155,810,003	149,663,889	10,480,531	197,214,760

Lead imported and entered for consumption in the United States, 1913–1918, by classes.

Year.	Lead in ore.		Base bullion.		Pigs, bars, and old.		Sheets, pipe, and shot.		Not otherwise specified.	Total value.
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.		
1913	2,306,972	$75,835	17,665,227	$388,116	4,621,270	$105,738	39,171	$3,291	$12,710	$585,690
1914	5,459,961	188,749	8,904,649	301,195	575,290	12,281	62,552	2,753	81,894	586,872
1915	2,865,792	96,010	15,496,230	519,355	997,368	32,951	201,510	17,059	107,580	772,955
1916	10,125,983	368,824	5,242,171	208,277	6,388,097	331,235	532	63	106,560	1,014,959
1917	5,438,931	207,370	6,965,849	470,539	1,756,223	85,743	12,538	2,699	10,287	776,638
1918	6,064,902	344,080	3,559,071	180,070	1,139,950	56,694	6,892	624	36,723	618,191

EXPORTS.

Lead exported from the United States, 1914–1918, by classes.

Year.	Pigs and bars.				Foreign lead used in articles exported with benefit of drawback.		Manufactures of lead from both domestic and foreign ores.
	From domestic ore.		From foreign ore.				
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Value.
1914	117,443,900	$4,501,674	43,090,375	$1,536,797	18,977,352	$733,000	$1,020,476
1915	176,612,208	7,928,518	77,236,303	2,738,263	7,966,372	353,235	2,174,946
1916	200,999,835	13,494,065	19,760,086	1,111,653	10,341,075	689,043	2,522,957
1917	107,376,638	9,560,598	75,304,480	6,650,157	15,074,947	1,296,445	2,288,205
1918	83,662,322	5,889,381	118,832,344	8,309,798	6,852,173	350,851	1,828,473

Pig lead exported from the United States, 1917 and 1918, by destination, in short tons.

Destination.	1917		1918	
	Domestic.	Foreign.	Domestic.	Foreign.
Canada	24,103	10,189	5,590	10,230
Great Britain	13,330	13,461	26,185	40,412
Netherlands	140	168	....	....
France	791	995	11	862
Italy	731	1,210	1,462	112
Russia	7,366	7,790	299	115
Japan	937	280	4,381	4,319
Other countries	6,290	3,559	3,903	3,366
	53,688	37,652	41,831	59,416

PRICES.

[See statement on p. 26A.]

LIME.

PRODUCTION.

Lime burned and sold in the United States, 1909–1918.

Year.	Quantity (short tons).	Value.[a]	Average price per ton.	Number of plants in operation.
1909	3,484,974	$13,846,072	$3.98	1,232
1910	3,505,954	14,088,039	4.02	1,125
1911	3,392,915	13,689,054	4.03	1,139
1912	3,529,462	13,970,114	3.96	1,017
1913	3,595,390	14,648,362	4.07	1,023
1914	3,380,928	13,268,938	3.92	954
1915	3,622,810	14,424,036	3.98	906
1916	4,073,433	18,509,305	4.54	778
1917	3,786,364	23,807,877	6.29	595
1918	3,206,016	26,808,909	8.36	496

[a] The value given represents the value of bulk lime f. o. b. at point of shipment and does not include weight or cost of barrel or package.

Lime sold in the United States in 1917 and 1918, by uses.

Use.	Percentage of total quantity.	Quantity (short tons).	Value.	Average price per ton.
1917.				
Building	34.7	1,313,493	$8,713,845	$6.63
Chemical	20.4	772,787	4,476,191	5.79
Paper mills	9.4	355,768	2,008,433	5.65
Glassworks	1.6	60,624	316,280	5.22
Sugar factories	1.3	47,546	381,746	8.03
Tanneries	1.8	66,629	408,976	6.14
Agriculture	12.9	488,297	2,475,731	5.07
Metallurgy	5.5	209,976	1,141,647	5.44
Dealers—uses not specified	5.1	194,028	1,245,654	6.42
Other [a]	7.3	277,216	2,639,374	9.52
	100.0	3,786,364	23,807,877	6.29
Hydrated lime (included in above totals)	....	709,157	4,643,004	6.55
1918.				
Building	28.5	914,186	7,781,388	8.51
Chemical	17.7	566,532	4,177,302	7.37
Paper mills	10.1	325,172	2,610,645	8.03
Glassworks	1.1	34,051	265,855	7.81
Sugar factories	1.1	36,494	314,748	8.62
Tanneries	2.3	74,350	637,960	8.58
Agriculture	12.2	391,047	2,698,848	6.90
Metallurgy	7.9	253,778	1,884,672	7.43
Dealers—uses not specified	3.5	111,343	960,596	8.63
Other [a]	15.6	499,063	5,476,895	10.97
	100.0	3,206,016	26,808,909	8.36
Percentage of increase or decrease in 1918	....	−15.3	+12.6	....
Hydrated lime (included in above totals)	....	620,216	5,342,113	8.61
Percentage of increase or decrease of hydrated lime in 1918	....	−12.5	+15.1	....

[a] Includes lime for sand-lime brick, slag cement, alkali works, sheep dipping, disinfectant, manufacture of soap, cyanide plants, glue factories, purification of water, etc.

Hydrated lime manufactured and sold in the United States, 1909–1918.

Year.	Quantity (short tons).	Value.	Average price per ton.	Number of plants reporting operations.
1909	204,611	$904,900	$4.43	50
1910	320,819	1,288,789	4.02	51
1911	304,593	1,372,057	4.50	60
1912	416,890	1,829,064	4.39	64
1913	493,269	2,205,657	4.47	80
1914	515,121	2,239,916	4.35	82
1915	581,114	2,457,602	4.23	84
1916	717,382	3,626,998	5.06	89
1917	709,157	4,643,004	6.55	90
1918	620,216	5,342,113	8.61	90

Hydrated lime sold in the United States in 1917 and 1918, by uses.

Use.	1917		1918	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Building	402,223	$2,694,143	312,599	$2,800,077
Chemical	52,255	354,177	31,107	282,501
Paper mills	6,728	43,513	10,756	101,523
Sugar factories	5,227	38,298	7,471	61,807
Tanneries	13,979	91,554	13,557	122,317
Glassworks	2,827	19,358	922	8,509
Agriculture	177,815	1,114,359	181,890	1,452,436
Dealers	30,630	170,732	32,555	249,590
Other	17,473	116,870	29,359	263,353
	709,157	4,643,004	620,216	5,342,113

IMPORTS.

Lime imported and entered for consumption in the United States, 1909–1918.[a]

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1909	8,687	$75,556	1914	3,455	$33,670
1910	6,498	63,791	1915	1,956	22,489
1911	5,232	55,255	1916	7,959	71,663
1912	4,268	48,153	1917	7,353	70,505
1913	4,139	48,538	1918	6,650	73,458

[a] Most of the lime imported into the United States comes from Canada.

EXPORTS.

Lime exported from the United States, 1913–1918.

Year.	Quantity (short tons).	Value.	Average price per ton.	Year.	Quantity (short tons).	Value.	Average price per ton.
1913	29,475	$212,345	$7.20	1916	23,973	$132,769	$5.54
1914	24,141	170,744	7.07	1917	18,794	168,671	8.97
1915	16,223	106,312	6.55	1918	7,191	105,803	14.71

LITHIUM MINERALS.

PRODUCTION.

Lithium minerals produced in the United States, 1909–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1909	189	$1,890	1914	525	$8,000
1910	238	2,380	1915	486	9,867
1911	500	9,000	1916	619	12,035
1912	360	6,800	1917	2,062	42,912
1913	530	14,900	1918	5,894	111,600

IMPORTS AND EXPORTS.

Imports and exports of lithium minerals are not reported separately.

LITHOGRAPHIC STONE.

PRODUCTION.

During 1913 and 1914 small quantities of lithographic stone were quarried at Brandenburg, Meade County, Ky. No domestic production was reported for 1915. Statistics are available since 1916 only.

Domestic lithographic stone sold in the United States, 1916–1918.

Year.	Quantity (pounds).	Value.
1916	40,000	$1,500
1917	5,832	489
1918	6,000	350

IMPORTS.

Value of lithographic stone imported for consumption in the United States, 1909–1918.

Year.	Value.	Year.	Value.
1909	$89,764	1914	$46,043
1910	97,502	1915	8,870
1911	106,232	1916	749
1912	88,994	1917	....
1913	70,984	1918	....

EXPORTS.

All lithographic stone produced in 1918 was exported to Japan.

MAGNESITE.

PRODUCTION.

Crude domestic magnesite sold or treated in the United States, 1913–1918.

Year.	California.		Washington.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	9,632	$77,056	....	....	9,632	$77,056
1914	11,293	124,223	....	....	11,293	124,223
1915	30,499	274,491	....	....	30,499	274,491
1916	154,259	1,388,331	715	$5,362	154,974	1,393,693
1917	211,663	2,116,630	105,175	783,188	316,838	2,899,818
1918	84,077	761,811	147,528	1,050,790	231,605	1,812,601

IMPORTS.

Imports are principally from Austria, Greece, and Canada.

Magnesite imported for consumption in the United States, 1916–1918.

	1916		1917		1918	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Magnesite:						
Calcined, not purified	9,270	$204,183	3,966	$232,601	19,049	$824,022
Crude	75,345	634,447	30,277	232,105	5,432	103,233

EXPORTS.

Exports are negligible and are not recorded.

MAGNESIUM.

PRODUCTION.

Production of metallic magnesium in the United States, 1915–1918.

Year.	Number of producers.	Quantity (pounds).	Value.	Average price per pound.
1915	3	87,500	$440,000	$5.00
1916	4	75,400	311,462	4.13
1917	5	115,813	233,626	2.02
1918	4	284,118	615,217	2.16

IMPORTS AND EXPORTS.

No information is obtained by the customs officials regarding imports and exports of magnesium alone. Prior to 1915 the entire domestic supply was imported. During 1917 and 1918 thousands of pounds were exported and sold to Great Britain, France, and Italy.

MANGANESE.

SUPPLY.

Manganese alloys and ore produced in the United States and imported from important foreign sources, 1913–1918, in long tons.

Year.	Steel.	Ferromanganese.		Spiegeleisen.		Manganese ore.				
	Production.[a]	Shipments.	Imports.	Shipments.	Imports.	Shipments.	Total imports.	Imports from—		
								Russia.	India.	Brazil.
1913	31,300,874	119,495	128,070	106,980	77	4,048	345,090	124,337	141,587	70,200
1914	23,513,030	100,731	82,997	76,625	2,870	2,635	283,294	52,681	103,583	113,924
1915	32,151,036	144,260	55,263	114,556	200	9,613	320,778	....	36,450	275,579
1916	42,773,680	224,103	90,928	182,837	....	31,474	576,321	....	51,960	471,837
1917	45,060,607	260,225	41,969	189,241	3,968	129,405	629,972	....	48,975	512,517
1918	44,462,432	306,076	27,168	263,861	1,969	305,869	491,303	....	29,275	345,877

[a] According to American Iron and Steel Institute.

PRODUCTION.

Manganese and manganiferous ore shipped from mines in the United States, 1909–1918.

Year.	Ore containing 35 per cent of manganese or more.		Ore containing 10 to 35 per cent of manganese.		Ore containing 5 to 10 per cent of manganese.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1909	1,544	$19,675	[a] 68,654	[b] $215,925	(a)	(b)
1910	2,258	22,892	41,260	[b] 186,765	19,841	(b)
1911	2,457	24,586	37,584	[b] 114,918	6,853	(b)
1912	1,664	15,723	40,863	[b] 19,942	10,654	(b)
1913	4,048	40,480	51,512	[b] 25,124	7,891	(b)
1914	2,635	27,377	91,666	[b] 218,497	6,599	(b)
1915	9,613	113,111	180,953	796,981	14,782	$20,173
1916	31,474	656,278	453,853	1,787,429	90,473	189,201
1917	129,405	4,109,722	730,759	3,036,292	130,185	369,769
1918	305,869	8,240,386	916,163	4,603,790	254,299	1,031,789

[a] Ore containing 5 to 10 per cent manganese included in figures for ore containing 10 to 35 per cent. Data not separable.

[b] Value of ore containing 5 to 10 per cent manganese included in figures for ore containing 10 to 35 per cent. Data not separable.

Manganiferous silver ore shipped from mines in the United States, 1909–1918, in long tons.

Year.	Arizona.	Colorado.	Nevada.	New Mexico.	Utah.
1909	....	65,024	....	....	....
1910	....	55,770	....	....	....
1911	....	41,753	....	....	....
1912	....	48,618	....	....	....
1913	....	49,753	....	....	....
1914	....	39,881	....	....	....
1915	1,452	30,921	104,498	....	55
1916	7,392	106,863	122,429	....	27
1917	32,009	124,715	122,872	....	100
1918	10,854	124,041	80,096	475	....

Manganiferous iron ore shipped from the Cuyuna district, Minn., 1913–1918, in long tons.

Year.	Ore containing 10 to 35 per cent of manganese.	Ore containing 5 to 10 per cent of manganese.	Year.	Ore containing 10 to 35 per cent of manganese.	Ore containing 5 to 10 per cent of manganese.
1913	26,200	....	1916	193,257	45,712
1914	55,192	....	1917	359,542	91,590
1915	42,973	....	1918	625,009	227,202

MANGANIFEROUS ZINC RESIDUUM.

PRODUCTION.

Unique deposits of zinc ore containing franklinite, willemite, zincite, calcite, and minor silicate and other minerals occur near Franklin Furnace, N. J. By mechanical and electromagnetic processes of separation three products are obtained from these ores, one containing the greater part of the franklinite and the remaining two the other zinc minerals. The franklinite product is first roasted with anthracite to eliminate the zinc, which is recovered as zinc oxide, and the residue, containing 12 to 15 per cent of manganese and 40 per cent of iron, is smelted to spiegeleisen.

No price is given for this material, as it is not sold in the open market, but is reduced to spiegeleisen by the company that produces it.

Manganiferous residuum produced from zinc roasting in the United States, 1909–1918.

Year.	Quantity (long tons).	Year.	Quantity (long tons).
1909	141, 264	1914	100, 198
1910	137, 173	1915	159, 318
1911	109, 296	1916	198, 817
1912	104, 670	1917	155, 332
1913	102, 239	1918	146, 796

MARL.

PRODUCTION.

Calcareous marl sold in the United States, 1916–1918.[a]

Year.	Quantity (short tons).	Value.	Average price per ton.
1916	58, 088	$144, 768	$2. 49
1917	73, 900	165, 223	2. 24
1918	98, 694	261, 082	2. 65
Percentage of increase in 1918	33. 6	58. 0	18. 3

[a] Statistics not available prior to 1916.

IMPORTS AND EXPORTS.

No imports or exports of marl are reported.

MICA.

PRODUCTION.

Mica produced and sold in the United States, 1913–1918.

Year.	Sheet mica.		Scrap mica.		Total quantity (short tons).	Total value.
	Quantity (pounds).	Value.	Quantity (short tons).	Value.		
1913	1, 700, 677	$353, 517	5, 322	$82, 543	6, 172	$436, 060
1914	556, 933	278, 540	3, 730	51, 416	4, 008	329, 956
1915	553, 821	378, 259	3, 959	50, 510	4, 236	428, 769
1916	865, 863	524, 485	4, 433	69, 906	4, 866	594, 391
1917	1, 276, 533	753, 874	3, 429	52, 908	4, 067	806, 782
1918	1, 644, 200	731, 810	2, 292	33, 130	3, 114	764, 940

IMPORTS.

Mica imported for consumption in the United States, 1913–1918.

Year.	Sheet.				Ground.		Total.	
	Unmanufactured.		Cut and splittings.					
	Quantity (pounds).	Value.	Quantity. (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1913	2,047,571	$751,092	(a)	$191,926	290,757	$4,765	(a)	$947,783
1914	360,888	168,591	(a)	456,805	404,848	4,088	(a)	629,484
1915	433,822	240,449	(a)	447,962	344,040	3,858	(a)	692,269
1916	703,832	421,856	(a)	646,080	362,000	3,420	(a)	1,071,356
1917	656,391	414,823	(a)	1,014,181	92,963	1,044	(a)	1,430,048
1918	741,429	658,576	(a)	880,906	11,587	1,647	(a)	1,541,129

a Quantity not reported.

EXPORTS.

Mica exported from the United States, 1913–1918.

Year.	Unmanufactured.		Manufactured.	Total value.
	Quantity (pounds).	Value.	Value.	
1913	298,711	$14,175	$48,009	$62,184
1914	467,451	23,145	27,751	50,896
1915	54,183	5,118	33,915	39,033
1916	63,168	4,544	74,127	78,671
1917	[a]11,771	3,073	71,412	74,485
1918	(b)	(b)	(b)	74,529

a For six months, January to June.
b Unmanufactured and manufactured not separately stated.

MILLSTONES.

[See under Abrasive materials.]

MINERAL PAINTS.

PRODUCTION.

Domestic natural mineral pigments[a] sold in the United States, 1909–1916.[b]

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1909	60,220	$567,028	1913	70,595	$512,410
1910	68,623	527,795	1914	66,766	633,390
1911	62,739	498,821	1915	57,442	551,598
1912	74,657	561,693	1916	(b)	(b)

a Include ocher, umber, sienna, metallic paint, mortar colors, and ground slate and shale.
b Canvass discontinued after 1915.

Domestic zinc and lead pigments,[a] made directly from ores, sold in the United States, 1909–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1909	87,525	$7,963,332	1914	106,791	$9,978,710
1910	75,162	6,852,804	1915	141,383	14,962,461
1911	80,611	7,343,762	1916	135,606	23,515,803
1912	106,497	9,507,895	1917	140,636	26,972,137
1913	97,573	9,020,896	1918	135,746	26,464,590

[a] Include sublimed blue lead, sublimed white lead, leaded zinc oxide, zinc oxide, and zinc lead.

MINERAL WATERS.

PRODUCTION.

Mineral waters sold in the United States, 1913–1918.

Year.	Commercial springs.	Quantity sold (gallons).	Value.	Average price per gallon (cents).
1913	838	57,867,399	$5,631,391	10
1914	829	54,358,466	4,892,328	9
1915	812	52,113,503	5,138,794	10
1916	802	55,928,461	5,735,035	10
1917	717	46,784,419	4,931,710	11
1918	569	40,709,722	4,533,001	11

IMPORTS.

Mineral waters imported for consumption in the United States, 1913–1918.

Year.	Quantity (gallons).	Value.	Average price per gallon (cents).	Year.	Quantity (gallons).	Value.	Average price per gallon (cents).
1913	3,364,676	$955,788	28	1916	1,553,199	$624,302	40
1914	2,786,142	857,707	31	1917	618,405	268,665	43
1915	1,528,181	551,648	36	1918	489,487	241,641	49

EXPORTS.

Large quantities of a few domestic waters are exported, but no statistics regarding such shipments are available. The quantity and the value of these waters are included in the statistics of production for the United States.

MOLYBDENUM.

PRODUCTION.

The quantity of molybdenum produced and sold in the United States in 1918 was the largest yet recorded by any country and amounted to 431 short tons of metal, in 2,280 tons of ore and concentrates, valued at $1,253,700.

Molybdenum in ore and concentrates produced and sold in the United States, 1914–1918.

Year.	Quantity sold (pounds).	Value.	Year.	Quantity sold (pounds).	Value.
1914	1,297	$1,297	1917	350,200	$495,350
1915	181,769	114,866	1918	861,637	1,253,700
1916	206,740	205,000			

IMPORTS AND EXPORTS.

No record of imports of molybdenum ores was kept by the Bureau of Foreign and Domestic Commerce before July 1, 1918. During the last six months of 1918, 140,222 pounds of ore, valued at $123,924, was imported. It is known that in the first half of the year 25,000 pounds of molybdenite, averaging about 75 per cent of MoS_2, was imported from Chosen and 19,000 pounds from some undesignated part of Asia.

For imports of molybdenum and ferromolybdenum combined see under "Ferroalloys." Exports of ferromolybdenum are not separately reported.

NICKEL.

PRODUCTION.

The United States produces no nickel from domestic materials except as a by-product of copper refining as shown in the following table. Large quantities of nickel matte imported from Canada and smaller quantities of matte made from New Caledonian ore are, however, refined in the United States.

Nickel content of nickel salts and metallic nickel produced as a by-product in the electrolytic refining of copper, 1911–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1911	445	$127,000	1915	822	$538,222
1912	328	93,600	1916	918	671,192
1913	241	79,393	1917	402	331,556
1914	423	313,000	1918	441	401,000

IMPORTS.

Nickel imported for consumption in the United States, 1913–1918.

Year.	Nickel, nickel ore and matte, nickel oxide, alloys of nickel with copper, etc.		Value of manufactured articles of nickel and nickel sheets and strips.	Total value.
	Quantity (pounds).	Value.		
1913	47,446,520	$6,562,555	$38,200	$6,600,755
1914	35,098,958	5,000,594	28,224	5,028,818
1915	56,599,381	7,629,686	6,458	7,636,144
1916	72,649,377	9,899,340	25,880	9,925,220
1917	75,526,767	9,617,163	45,248	9,662,411
1918	73,207,147	11,520,775	115,243	11,636,018

Nickel imported for consumption in the United States, 1916–1918, by forms.

Form.	1916		1917		1918	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Nickel, alloys, pig, bars, etc	29,917	$7,869	48	$19	40	$8
Ore and matte (nickel content)	72,611,492	9,889,122	75,510,793	9,612,400	73,193,205	11,517,546
Nickel oxide	7,968	2,349	15,926	4,744	13,902	3,221
Nickel sheets and strips		4,896			8,612	6,881
Nickel, all other manufactures of		20,984		45,248	10,495	108,362
	72,649,377	9,925,220	75,526,767	9,662,411	73,226,254	11,636,018

Imports of nickel ore and matte in 1917 and 1918, by countries.

Country.	1917			1918				
	Nickel ore and matte.			Nickel ore and matte.			Manufactures.	
	Quantity (short tons).	Nickel content (pounds).	Value.	Quantity (short tons).	Nickel content (pounds).	Value.	Quantity (pounds).	Value.
Canada	65,916	73,530,259	$9,138,994	63,835	70,645,034	$10,974,325	9,518	$4,441
Australia	2,463	1,980,534	473,406	2,339	2,027,850	433,878		
Other British Oceania				489	409,023	85,934		
Chile				1	91	44		
French Oceania				112	111,207	23,365		
France							86	411
Switzerland							1,172	12,339
England							9,328	5,517
Japan							4,870	6,671
	68,379	75,510,793	9,612,400	66,776	73,193,205	11,517,546	24,974	29,379

EXPORTS.

Nickel, nickel oxide, and matte[a] exported from the United States, 1909–1918.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1909	12,048,737	$4,101,976	1914	27,595,152	$9,455,528
1910	15,244,937	4,704,088	1915	26,418,550	10,128,514
1911	25,099,586	8,283,777	1916	33,404,011	12,952,493
1912	25,815,016	8,515,332	1917	21,992,820	8,936,620
1913	29 173,088	9,686,794	1918	17,469,500	6,927,041

[a] No nickel matte is known to have been exported in the years 1911 to 1918, inclusive.

Manufactures of nickel were exported to the value of $2,152,692.

OILSTONES AND SCYTHESTONES.

[See under Abrasive materials.]

PEAT.

PRODUCTION.

Crude air-dried peat used in the United States, 1909–1918.

Year.	Fertilizer and fertilizer ingredient.		Stock food.		Fuel.		Other products.[a]		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1909	26,768	$118,891	....	....	1,145	$4,145	1,254	$4,006	29,167	$127,042
1910	37,024	140,209	....	....	....	....	....	....	37,024	140,209
1911	51,733	257,204	....	....	300	1,500	3,110	13,410	55,143	272,114
1912	41,080	186,022	3,000	$18,000	1,300	4,500	2,000	20,050	47,380	228,572
1913	28,460	169,600	4,800	27,600	....	....	....	....	33,260	197,200
1914	37,729	249,899	(b)	(b)	1,925	6,540	7,439	53,253	[b]47,093	[b]309,692
1915	38,304	258,447	3,980	30,090	....	....	....	....	42,284	288,537
1916	48,106	336,004	4,300	32,250	(c)	(c)	100	850	52,506	369,104
1917	92,263	658,500	5,100	51,400	....	....	....	....	97,363	709,900
1918	79,573	775,313	7,096	106,935	20,567	164,745	25	250	107,261	1,047,243

[a] Peat moss, paper stock, and packing material. Also peat fuel in 1916.
[b] Figures for stock food not available.
[c] Included under "Other products."

IMPORTS.

Peat moss imported for consumption in the United States, 1913–1918.

Year.	Quantity (short tons).	Value.	Average price per ton.	Year.	Quantity (short tons).	Value.	Average price per ton.
1913	10,983	$55,719	$5.07	1916	3,042	$27,859	$9.16
1914	9,921	57,542	5.80	1917	506	4,966	9.81
1915	7,514	48,142	6.41	1918	0	....	....

EXPORTS.

No exports of peat are reported.

PETROLEUM.

PRODUCTION.

Petroleum produced in the United States, 1859–1918, by fields, in barrels of 42 gallons.

Year.	Appalachian.	California.	Lima-Indiana.	Rocky Mountain.	Illinois.
Prior to 1913	1,075,612,494	543,709,707	423,623,794	12,235,618	186,512,968
1913	25,921,785	97,788,525	4,773,138	2,595,321	23,893,899
1914	24,101,048	99,775,327	5,062,543	3,783,148	21,919,749
1915	22,860,048	86,591,535	4,269,591	4,454,000	19,041,695
1916	23,009,455	90,951,936	3,905,003	6,476,289	17,714,235
1917	24,932,205	93,877,549	3,670,293	9,199,310	15,776,860
1918	25,401,466	97,531,997	3,220,722	12,808,896	13,365,974
Grand total since production began	1,221,838,501	1,110,226,576	448,525,084	51,552,582	298,225,380

Petroleum produced in the United States, 1859–1918, by fields, in barrels of 42 gallons—Continued.

Year.	Mid-Continent.	Gulf.	Other.[a]	United States.
Prior to 1913	385,595,568	193,904,149	54,077	2,821,248,375
1913	84,920,225	8,542,494	10,843	248,446,230
1914	97,994,900	13,118,028	7,792	265,762,535
1915	123,294,317	20,578,653	14,265	281,104,104
1916	136,934,439	21,768,096	7,705	300,767,158
1917	163,506,205	24,342,879	10,300	335,315,601
1918	179,383,098	24,207,620	7,943	355,927,716
Grand total since production began	1,171,628,752	306,461,919	112,925	4,608,571,719

[a] Alaska, Michigan, Missouri, and New Mexico.

Petroleum produced in the United States, 1917 and 1918, by States and fields.

State and field.	1917			1918			Increase or decrease in quantity in 1918.	
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Barrels.	Per cent.
California	93,877,549	$86,161,764	$0.918	97,531,997	$118,770,790	$1.218	+ 3,654,448	+ 3.89
Colorado	121,231	128,100	1.057	143,286	188,472	1.315	+ 22,055	+ 18.19
Illinois	15,776,860	31,358,069	1.988	13,365,974	31,230,000	2.337	− 2,410,886	− 15.28
Indiana	759,432	1,470,548	1.936	877,558	2,028,129	2.311	+ 118,126	+ 15.55
Kansas	36,536,125	67,120,573	1.837	45,451,017	100,546,202	2.212	+ 8,914,892	+ 24.40
Kentucky	3,088,160	7,033,714	2.278	4,367,968	11,287,162	2.584	+ 1,279,808	+ 41.44
Louisiana	11,392,201	17,224,602	1.600	16,042,600	27,535,060	1.716	+ 4,650,399	+ 40.82
Montana	99,399	146,272	1.472	69,323	125,828	1.815	− 30,076	− 30.26
New York	879,685	2,850,378	3.240	808,843	3,307,814	4.089	− 70,842	− 8.05
Ohio	7,750,540	21,104,483	2.723	7,285,005	23,465,197	3.221	− 465,535	− 6.01
Oklahoma	107,507,471	181,646,981	1.690	103,347,070	231,136,205	2.237	− 4,160,401	− 3.87
Pennsylvania	7,733,200	25,154,290	3.253	7,407,812	29,606,079	3.997	− 325,388	− 4.21
Tennessee	12,196	28,448	2.333	8,374	21,704	2.592	− 3,822	− 31.34
Texas	32,413,287	42,891,555	1.323	38,750,031	74,867,537	1.932	+ 6,336,744	+ 19.55
West Virginia	8,379,285	27,246,960	3.252	7,866,628	31,652,018	4.024	− 512,657	− 6.12
Wyoming	8,978,680	11,047,876	1.230	12,596,287	18,159,778	1.442	+ 3,617,607	+ 40.29
Other [a]	10,300	20,600	2.000	7,943	15,986	2.013	− 2,357	− 22.88
	335,315,601	522,635,213	1.559	355,927,716	703,943,961	1.978	+20,612,115	+ 6.15
Appalachian	24,932,205	77,786,495	3.120	25,401,466	93,917,171	3.697	+ 469,261	+ 1.88
Lima-Indiana	3,670,293	7,102,326	1.935	3,220,722	7,450,932	2.313	− 449,571	− 12.25
Illinois	15,776,860	31,358,069	1.988	13,365,974	31,230,000	2.337	− 2,410,886	− 15.28
Mid-Continent	163,506,205	282,796,124	1.730	179,383,098	393,031,158	2.191	+15,876,893	+ 9.71
Gulf	24,342,879	26,087,587	1.071	24,207,620	41,053,846	1.696	− 135,259	− .56
California	93,877,549	86,161,764	.918	97,531,997	118,770,790	1.218	+ 3,654,448	+ 3.89
Rocky Mountain	9,199,310	11,322,248	1.231	12,808,896	18,474,078	1.442	+ 3,609,586	+ 39.24
Other fields [a]	10,300	20,600	2.000	7,943	15,986	2.013	− 2,357	− 22.88
	335,315,601	522,635,213	1.559	355,927,716	703,943,961	1.978	+20,612,115	+ 6.15

[a] Alaska and Michigan.

World's production of crude petroleum in 1918 and since 1857, by countries.

Country.	Production, 1918.			Total production, 1857–1918.		
	Barrels of 42 gallons.	Metric tons.	Percentage of total.	Barrels of 42 gallons.	Metric tons.	Percentage of total.
United States	355, 927, 716	47, 457, 029	69. 15	4, 608, 571, 719	614, 476, 230	61. 41
Mexico	63, 828, 327	9, 506, 289	12. 40	285, 182, 489	42, 564, 549	3. 80
Russia	40, 456, 182	5, 520, 066	7. 86	1, 873, 999, 199	247, 983, 276	24. 97
Dutch East Indies[a]	13, 284, 936	1, 836, 914	2. 58	188, 388, 513	25, 465, 114	2. 51
Rumania	8, 730, 235	1, 214, 219	1. 70	151, 408, 411	21, 058, 193	2. 02
India	[b] 8, 000, 000	[b] 1, 066, 667	1. 55	106, 162, 365	14, 154, 982	1. 41
Persia	[b] 7, 200, 000	[b] 1, 000, 000	1. 40	14, 056, 063	1, 952, 231	. 19
Galicia	5, 591, 620	777, 640	1. 09	154, 051, 273	21, 424, 303	2. 05
Peru	[c] 2, 536, 102	[c] 338, 147	. 49	24, 414, 387	3, 255, 251	. 33
Japan and Formosa	2, 449, 069	326, 543	. 48	38, 498, 247	5, 133, 100	. 51
Trinidad	2, 082, 068	289, 578	. 40	7, 432, 391	1, 033, 712	. 10
Egypt	2, 079, 750	277, 300	. 40	4, 848, 436	646, 458	. 07
Argentina	1, 321, 315	192, 612	. 26	4, 296, 093	617, 176	. 08
Germany	[b] 711, 260	[b] 100, 000	. 14	16, 664, 121	2, 254, 974	. 22
Canada	304, 741	40, 632	. 06	24, 425, 770	3, 256, 769	. 33
Venezuela	190, 080	26, 400	. 04	317, 823	44, 142	. 02
Italy	[b] 35, 953	[b] 5, 000		973, 671	138, 588	
Cuba	....	....	....	19, 167	2, 662	
Other countries	....	....	....	397, 000	55, 139	
	514, 729, 354	69, 975, 036	100. 00	7, 504, 107, 138	1, 005, 516, 849	100. 00

[a] Includes British Borneo. [b] Estimated. [c] Estimated in part.

STOCKS.

Stocks of all grades of petroleum at the end of 1917 and 1918, in barrels.

Grade of oil.	Held by eastern pipe lines and refineries.[a]		In pipe-line storage outside of eastern field.		Total.		Increase or decrease.
	1917	1918	1917	1918	1917	1918	
Pennsylvania[b]	3, 821, 416	3, 616, 363	....	....	3, 821, 416	3, 616, 363	− 205, 053
Lima	1, 906, 241	1, 028, 808	....	....	1, 906, 241	1, 028, 808	− 877, 433
Illinois[c]	502, 312	424, 604	3, 057, 910	1, 942, 148	3, 560, 222	2, 366, 752	− 1, 193, 470
Mid-Continent	4, 356, 420	4, 176, 355	95, 070, 003	74, 917, 288	99, 426, 423	79, 093, 643	−20, 332, 780
Gulf	....	....	8, 384, 814	8, 168, 402	8, 384, 814	8, 168, 402	− 216, 412
California	....	....	28, 427, 292	26, 538, 610	28, 427, 292	26, 538, 610	− 1, 888, 682
Rocky Mountain	....	....	515, 341	914, 734	515, 341	914, 734	+ 399, 393
	10, 586, 389	9, 246, 130	135, 455, 360	112, 481, 182	146, 041, 749	121, 727, 312	−24, 314, 437

[a] These pipe lines connect with the delivering lines of the Illinois, Kansas, and Oklahoma fields and receive and transfer large quantities of these western oils to the Atlantic seaboard in addition to the oil from wells directly tributary to their own systems.

[b] Includes natural lubricating oil from Pennsylvania and West Virginia.

[c] Includes some Indiana oil of Illinois grade.

Petroleum in field storage at end of 1917 and 1918, in barrels.

Field.	1917	1918	Field.	1917	1918
Appalachian	310, 966	242, 291	Gulf	121, 001	413, 582
Lima-Indiana	71, 018	26, 032	Rocky Mountain	294, 524	260, 040
Illinois	213, 349	298, 225	California	4, 316, 922	4, 123, 821
Mid-Continent	8, 378, 031	2, 183, 106			
				13, 705, 811	7, 547, 097

IMPORTS AND EXPORTS.

Imports and exports of crude petroleum, 1913–1918.

Year.	Imports.[a]		Exports.[b]	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1913	17,809,058	$12,947,280	4,630,229	$8,448,294
1914	17,247,483	11,465,466	2,969,894	4,958,838
1915	18,140,110	10,389,012	3,768,168	4,282,827
1916	20,570,075	12,602,811	4,095,902	7,029,923
1917	30,162,583	16,400,017	4,098,124	7,668,312
1918	37,735,641	21,319,464	4,900,691	12,084,250

[a] Imports of crude oil into the United States are chiefly from Mexico, with small quantities from other countries.

[b] Exports of crude petroleum are chiefly to Canada. Exports of refined products are not included nor are shipments of crude petroleum to Alaska, Hawaii, Porto Rico, and the Philippine Islands.

PHOSPHATE ROCK.

PRODUCTION.

Phosphate rock sold in the United States, 1909–1918.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1909	2,338,264	$10,796,456	1914	2,734,043	$9,608,041
1910	2,654,988	10,917,000	1915	1,835,667	5,413,449
1911	3,053,279	11,900,693	1916	1,982,385	5,896,993
1912	2,973,332	11,675,774	1917	2,584,287	7,771,084
1913	3,111,221	11,796,231	1918	2,490,760	8,214,463

Phosphate rock sold in the United States, 1917 and 1918, by States.

State.	1917			1918		
	Quantity (long tons).	Value.	Average price per ton.	Quantity (long tons).	Value.	Average price per ton.
Florida:						
Hard and soft rock	18,608	$159,366	$8.56	70,383	$524,178	$7.45
Land pebble	2,003,991	5,305,127	2.65	1,996,847	5,565,928	2.79
	2,022,599	5,464,493	2.70	2,067,230	6,090,106	2.95
South Carolina:						
Land rock	33,485	138,482	4.14	37,040	164,650	4.45
Tennessee:						
Brown rock	[a] 447,203	1,920,533	4.29	[a] 374,535	1,917,546	5.12
Blue rock	65,904	205,820	3.12			
	[a] 513,107	2,126,353	4.14	[a] 374,535	1,917,546	5.12
Western States[b]	15,096	41,756	2.77	11,955	42,161	3.53
	2,584,287	7,771,084	3.01	2,490,760	8,214,463	3.30

[a] Includes several thousand tons of brown rock from Kentucky.

[b] 1917: Idaho, Utah, and Wyoming; 1918: Idaho and Utah.

IMPORTS.

Imports of phosphate rock are negligible.

EXPORTS.

Phosphate rock marketed in and exported from the United States, 1913–1918.

Year.	Sales (long tons).	Exports (long tons).	Proportion of exports to total sales (per cent).	Year.	Sales (long tons).	Exports (long tons).	Proportion of exports to total sales (per cent).
1913	3,111,221	1,366,508	44	1916	1,982,385	243,678	12
1914	2,734,043	964,114	35	1917	2,584,287	166,358	6
1915	1,835,667	253,421	14	1918	2,490,760	143,455	6

PLATINUM AND ALLIED METALS.

PRODUCTION.

REFINED PLATINUM.

Reports received from refiners of platinum, gold bullion, nickel, and copper indicate that 59,753 troy ounces of refined new metals of the platinum group was recovered in 1918, of which about 10,693 ounces is believed to be of domestic origin.

New platinum and allied metals recovered by refiners, 1915–1918, in troy ounces.

Year.	Platinum.	Iridium.	Iridosmine-osmiridium.	Palladium.	Rhodium.
1915	6,495	274	355	1,541	....
1916	24,518	370	315	2,885	....
1917	33,009	210	833	4,779	....
1918	54,399	465	539	4,024	326

SECONDARY PLATINUM.

Dealers and refiners reported sales in 1918 of 45,583 ounces of secondary platinum metals derived from refining scrap and sweeps. The figures that make up this total probably represent some duplication, as the same metal may be handled as scrap several times in a year.

Secondary platinum and allied metals sold, 1915–1918, in troy ounces.

Year.	Platinum.	Iridium.	Palladium.
1915	42,149	863	958
1916	45,156	1,535	1,284
1917	59,007	9,832	3,347
1918	40,378	3,410	1,795

WORLD'S PRODUCTION.

Statistics of the world's production of platinum and allied metals are at best estimates, though they are derived from the most reliable information obtainable. There are no reliable data upon which to base estimates of the production of platinum in Russia. In fact it seems doubtful whether any platinum was mined in that country in 1918, as much of the fighting during the later part of the year was in the vicinity of the platinum fields.

Estimated world's production of crude platinum, 1911–1918, in troy ounces.

Country.	1911	1912	1913	1914	1915	1916	1917	1918
Borneo, India, and Sumatra	....	....	200	(a)	[b] 18	[b] 9	[c] 52	(a)
Canada	30	30	50	30	100	60	80	75
Colombia	12,000	12,000	15,000	17,500	18,000	25,000	32,000	35,000
New South Wales and Tasmania	470	778	1,500	1,248	303	222	330	811
Russia	300,000	300,000	250,000	241,200	124,000	63,900	50,000	(a)
United States	628	721	483	570	742	750	605	647
	313,128	313,529	267,233	260,548	143,163	89,941	83,067	36,533

[a] No basis for estimate. [b] India only. [c] Dutch East Indies and India.

IMPORTS.

Platinum and allied metals imported for consumption in the United States, 1917–1918.

Metal.	1917		1918	
	Quantity (troy ounces).	Value.	Quantity (troy ounces).	Value.
Platinum or crude platinum and unmanufactured products, ingots, bars, sheets, wire	30,207	$2,408,188	54,963	$4,949,855
Platinum, manufactured products, vases, retorts, etc.	(a)	1,347	(a)	8,597
Iridium	3,619	378,678	1,126	126,282
Osmiridium	259	25,456	427	46,321
Osmium	400	23,359	....	....
Palladium	1,239	117,192	240	36,853
	35,724	2,954,220	56,756	5,167,908

[a] Quantity not given.

Platinum imported into the United States, 1915–1918.[a]

[General imports.]

	Unmanufactured.		Ingots, bars, etc.		Manufactured products, vases, etc.	Total value.
	Quantity (troy ounces).	Value.	Quantity (troy ounces).	Value.		
1915	55,729	$2,077,536	5,708	$262,940	$71,532	$2,412,008
1916	41,236	2,506,531	12,248	631,865	18,923	3,157,319
1917	26,146	2,095,390	4,170	319,383	382	2,415,155
1918:						
France	376	39,006	....	....	....	39,006
England	193	17,948	202	19,910	11,458	49,316
Netherlands	....	....	....	....	433	433
Canada	75	7,924	200	20,978	[b] 1,634	30,536
Costa Rica	....	....	3	500	....	500
Panama	471	43,439	872	75,040	....	118,479
Cuba	....	....	6	575	....	575
Dominican Republic	....	....	3	214	....	214
Brazil	27	2,312	....	....	....	2,312
Chile	142	12,099	....	....	....	12,099
Colombia	22,974	1,973,099	7,569	657,524	[b] 700	2,631,314
Ecuador	....	....	2	219	....	219
Peru	3	300	....	....	....	300
Venezuela	16	1,610	8	438	....	2,048
China	423	34,267	....	....	....	34,267
Dutch East Indies	21	1,339	....	....	....	1,339
Japan	112	11,406	228	26,251	....	37,657
Russia in Asia	21,000	2,000,000	....	....	....	2,000,000
British South Africa	....	....	36	3,366	....	3,366
	45,833	4,144,740	9,129	805,015	14,225	4,963,980

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[a] Does not include platinum manufactures "Not specially provided for" in the tariff act, upon which a duty of 50 per cent is imposed.

[b] Six months, January to June.

EXPORTS.

Platinum exported from the United States, 1913–1918.

Year.	Domestic.			Foreign.				
	Unmanufactured.		Manufactures.	Unmanufactured.		Manufactures.		
						Ingots, bars, etc.		Vases.
	Quantity (troy ounces).	Value.	Value.	Quantity (troy ounces).	Value.	Quantity (troy ounces).	Value.	Value.
1913	(a)	(a)	(a)	926	$29,510	265	$10,490	$10,000
1914	(a)	(a)	(a)	....	....	143	6,560	107
1915	(a)	(a)	(a)	....	....	9	416	....
1916	1,145	$97,988	$83,864	....	....	....	3	....
1917	3,445	234,433	65,415	....	....	11	1,200	....
1918	119	13,511	23,562	....	....	....	....	....

[a] Not separately classified prior to 1916.

POTASH.

PRODUCTION.

Potash produced and sold in the United States, 1915–1918.[a]

	Number of producers.	Production.			Sales.		
		Crude potash (short tons).	Available content of potash (K_2O).		Crude potash (short tons).	Available content of potash (short tons).	Value. f. o. b. plant.
			Quantity (short tons).	Percentage of total.			
1915	5	4,374	1,090	....	4,374	1,090	$342,000
1916	70	35,739	9,720	....	35,739	9,720	4,242,730
1917	95	126,961	32,573	....	126,961	32,573	13,980,577
1918:							
Mineral—							
Natural brines—							
Nebraska lakes	19	116,662	28,854	53	57,522	14,011	5,098,023
Other sources	8	32,390	10,862	20	30,849	10,319	4,184,442
Alunite	4	6,180	2,621	5	6,180	2,621	1,276,774
Dust from cement mills	12	12,652	1,549	3	11,172	1,366	539,567
Dust from blast furnaces Silicate rocks	6	3,155	310	.5	3,155	310	152,571
Organic—							
Kelp	8	14,029	4,804	9	14,029	4,804	2,296,983
Molasses, distillery waste	8	11,792	3,467	6	11,792	3,467	1,335,516
Steffens water from beet-sugar refineries	8	8,795	1,374	2	3,650	742	267,309
Wood ashes	51	1,100	673	1	1,063	651	549,745
Wool washings and miscellaneous	4	931	289	.5	931	289	138,688
	128	207,686	54,803	100	140,343	38,580	15,839,618

[a] Production and sales were practically the same from 1915 to 1917, and no distinction was made between them.

IMPORTS.

Potash salts imported and entered for consumption in the United States, 1913–1918.

Year.	Potash salts [a] used mainly in the fertilizer industry.			Potash salts [b] used mainly in chemical industries.			Total.		
	Quantity (short tons).		Value.	Quantity (short tons).		Value.	Quantity (short tons).		Value.
	Gross weight.	Potash (K_2O) content.		Gross weight.	Potash (K_2O) content.		Gross weight.	Potash (K_2O) content.	
1913	1,053,684	256,101	$13,200,413	38,904	15,619	$4,873,452	1,092,588	270,720	$18,073,865
1914	766,796	193,878	10,700,199	31,291	13,211	4,721,412	798,087	207,089	15,421,611
1915	100,256	42,519	3,257,114	16,430	6,348	3,001,234	116,686	48,867	6,258,348
1916	4,273	1,726	453,091	22,369	6,159	6,972,307	26,642	7,885	7,425,398
1917	1,165	504	189,159	24,122	7,596	7,599,247	25,287	8,100	7,788,406
1918	525	261	117,438	23,894	7,696	8,790,398	24,419	7,957	8,907,836

[a] Kainite, manure salts, muriate, and sulphate.

[b] Bicarbonate, bichromate, bitartrate, carbonate, caustic, chlorate, chromate, cyanide, ferricyanide, ferrocyanide, iodide, nitrate, permanganate, and Rochelle salt.

EXPORTS.

Exports of domestic potash salts in 1917 and 1918.

Material.	1917 [a]			1918		
	Quantity (short tons).		Value.	Quantity (short tons).		Value.
	Gross weight.	Potash (K_2O) content.		Gross weight.	Potash (K_2O) content.	
Potassium chlorate	525	200	$475,434	696	264	$534,491
All other potassium salts	....	....	638,768	....	....	837,679
	....	....	1,114,202	....	....	1,372,170

[a] Covers 6 months beginning July 1, 1917.

PUMICE.

[See under Abrasive materials.]

PYRITES.

PRODUCTION.

Pyrites produced in the United States, 1909–1918.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1909	247,070	$1,028,157	1914	336,662	$1,283,346
1910	241,612	977,978	1915	394,124	1,674,933
1911	301,458	1,164,871	1916	439,132	2,038,002
1912	350,928	1,334,259	1917	482,662	2,593,035
1913	341,338	1,286,084	1918	464,494	2,644,515

IMPORTS.

Pyrites containing more than 25 per cent of sulphur imported for consumption in the United States, 1909–1918.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1909	688,843	$2,428,580	1914	1,026,617	$4,797,326
1910	803,551	2,748,647	1915	964,634	4,817,977
1911	1,006,310	3,788,803	1916	1,244,662	6,728,318
1912	970,785	3,841,683	1917	967,340	5,981,457
1913	850,592	3,611,137	1918	496,792	2,741,676

EXPORTS.

No exports of pyrites are reported.

QUICKSILVER.

SUPPLY.

Supplies of quicksilver in the United States, 1913–1918.

[Flasks of 75 pounds.]

Year.	Production.		Imports for consumption.		Exports.		Apparent consumption.[a]	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1913	20,213	$813,171	2,289	$75,361	1,140	$43,574	21,362	$844,958
1914	16,548	811,680	8,198	271,984	1,446	70,753	23,300	1,012,911
1915	21,033	1,804,631	5,625	282,752	3,372	225,509	23,286	1,861,874
1916	29,932	3,768,139	5,659	515,919	8,880	670,475	26,711	3,613,583
1917	36,159	3,808,266	5,207	448,032	10,778	998,470	30,588	3,257,828
1918	32,883	3,863,752	6,719	533,622	3,098	338,620	36,504	4,058,754

[a] Production plus imports minus exports.

PRODUCTION.

Quicksilver produced in the United States, 1916–1918, by States.

[Flasks of 75 pounds.]

State.	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Arizona	5	$629	40	$4,213		
Oregon	[a] 378	47,587	388	40,864	702	$82,485
Texas	6,306	793,862	10,791	1,136,508	8,451	992,992
California	21,045	2,649,355	23,938	2,521,151	22,664	2,663,020
Nevada	2,198	276,706	997	105,004	1,044	122,670
Idaho			5	526	22	2,585
	29,932	3,768,139	36,159	3,808,266	32,883	3,863,752

[a] Includes 75 flasks from Washington.

PRICES.

Average yearly prices of quicksilver in the United States and the United Kingdom, 1909 to 1918.

[Per flask of 75 pounds.]

Year.	San Francisco[a] (domestic).	New York.[b]	London.[c] £	s.	d.	Year.	San Francisco[a] (domestic).	New York.[b]	London.[c] £	s.	d.
1909	$45.45	$46.30	8	12	0	1914	$49.05	$48.31	[d]7	15	0
1910	46.51	47.06	8	16	0	1915	85.80	87.01	14	10	8
1911	46.01	46.54	8	4	11	1916	125.89	125.49	17	2	10
1912	42.05	42.46	8	2	10	1917	105.32	106.30	22	4	8
1913	40.23	39.54	7	9	2	1918	117.50	123.47		([e])	

[a] Min. and Sci. Press, San Francisco.
[b] Eng. and Min. Jour., New York.
[c] Min. Jour. (London).
[d] Metal exchange closed about three months after outbreak of war. Average based on 37 weeks only.
[e] Quoted as "nominal" only.

Prices of domestic quicksilver at San Francisco, 1914-1918, by months.

[Per flask of 75 pounds.]

Month.	1914	1915	1916	1917	1918
January	$39.25	$51.90	$222.00	$81.00	$128.06
February	39.00	60.00	295.00	126.25	118.00
March	39.00	78.00	219.00	113.75	112.00
April	38.90	77.50	141.60	114.50	115.00
May	39.00	75.00	90.00	104.00	110.00
June	38.60	90.00	74.70	85.50	112.00
July	37.50	95.00	81.20	102.00	120.00
August	80.00	93.75	74.50	115.00	120.00
September	[a] 76.25	91.00	75.00	112.00	120.00
October	53.00	92.90	78.20	102.00	120.00
November	55.00	101.50	79.50	102.50	120.00
December	53.10	123.00	80.00	117.42	115.00

[a] Market fluctuated greatly at outbreak of European war.

RADIUM.

[See under Uranium and vanadium ores.]

SALT.

SUPPLY.

Supplies of salt for domestic consumption, 1900-1918, in short tons.

	1900	1910	1915	1917	1918
Domestic production	2,921,708	4,242,792	5,352,409	6,978,177	7,238,744
Imports	199,909	137,103	122,326	64,922	40,290
Total supply	3,121,617	4,379,895	5,474,735	7,043,099	7,279,034
Exports	7,511	49,013	80,474	113,993	136,783
Domestic consumption	3,114,106	4,330,882	5,394,261	6,929,106	7,142,251
Comparison with preceding year	+178,449	+6,444	+473,096	+528,186	+213,145
Percentage of imports to total consumption	6.4	3.2	2.3	0.9	0.6

PRODUCTION.

Salt produced and marketed in the United States, 1913–1918.

Year.	Quantity (short tons).				Total value.	Average price per ton.
	Manufactured (evaporated).	In brine.	Rock salt.	Total.		
1913	2,131,229	1,622,382	1,062,291	4,815,902	$10,123,139	$2.10
1914	2,159,094	1,652,758	1,060,804	4,872,656	10,197,417	2.09
1915	2,335,823	1,851,199	1,165,387	5,352,409	11,747,686	2.19
1916	2,454,836	2,539,717	1,368,353	6,362,906	13,645,947	2.14
1917	2,482,564	2,890,588	1,605,025	6,978,177	19,940,442	2.86
1918	2,724,203	2,830,600	1,683,941	7,238,744	26,940,361	3.72

SAND AND GRAVEL.

PRODUCTION.

Sand and gravel produced in the United States, 1913–1918.

Year.	Glass sand.		Molding sand.		Building sand.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	1,791,800	$1,895,991	3,563,583	$2,230,217	25,397,383	$8,007,949
1914	1,619,649	1,568,030	2,751,209	1,756,383	24,003,962	7,688,774
1915	1,884,044	1,606,640	3,585,746	2,123,203	22,921,426	6,884,267
1916	2,018,317	1,957,797	4,662,649	3,219,839	27,193,462	8,569,675
1917	1,942,675	2,685,014	4,660,968	4,308,809	25,374,987	9,837,688
1918	2,172,887	4,209,728	4,910,178	5,121,865	19,686,885	9,772,556

Year.	Other sand.		Gravel.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	7,941,389	$2,973,688	40,861,694	$9,109,663	79,555,849	$24,217,506
1914	9,577,628	3,112,175	41,329,287	9,721,637	79,281,735	23,846,999
1915	7,550,773	2,558,991	40,661,314	9,948,516	76,603,303	23,121,617
1916	9,089,550	3,842,538	46,127,754	12,220,146	89,091,732	29,809,995
1917	8,866,876	4,962,232	35,573,819	13,508,189	76,419,325	35,296,932
1918	6,349,870	5,259,620	28,704,606	13,563,310	61,824,426	37,927,079

IMPORTS AND EXPORTS.

Imports and exports of sand and gravel, 1913–1918.[a]

Year.	Imports.	Exports.	Year.	Imports.	Exports.
1913	$172,257	(b)	1916	$87,144	$233,310
1914	139,675	(b)	1917	142,586	494,251
1915	96,754	(b)	1918	91,465	619,414

[a] These imports and exports are mostly building sand shipped from and to Canada.
[b] Not reported separately.

SAND-LIME BRICK.

PRODUCTION.

Sand-lime brick sold in the United States, 1909–1918.

Year.	Number of operators reporting sales.	Quantity (thousands).	Value.	Year.	Number of operators reporting sales.	Quantity (thousands).	Value.
1909	74	151,809	$1,150,580	1914	62	172,629	$1,058,512
1910	76	172,507	1,169,153	1915	56	179,643	1,135,104
1911	66	142,963	897,664	1916	53	227,344	1,474,078
1912	71	178,541	1,200,223	1917	47	187,546	1,420,330
1913	68	189,659	1,238,325	1918	42	98,399	883,929

IMPORTS AND EXPORTS.

Imports and exports of sand-lime brick are not reported separately.

SELENIUM.

PRODUCTION.

The output of selenium by four producing companies in 1918 was 103,694 pounds, valued at about $206,540, as against 39,630 pounds, valued at $70,000, in 1917. Most of the selenium produced is a by-product in the electrolytic refining of copper.

IMPORTS.

Selenium and selenium salts imported for consumption in the United States, 1913–1918.

1913	$320	1916	$302
1914	43	1917	2,236
1915	59	1918	0

SILICA (QUARTZ).

PRODUCTION.

Silica sold for pottery, paints, fillers, polishers, abrasives, and other uses, 1916–1918.

Material.	1916		1917		1918	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Quartz (vein quartz, pegmatite, and quartzite)	88,514	$242,786	142,673	$318,069	71,740	$259,330
Sand and sandstone [a]	110,603	489,863	532,454	1,195,142	98,956	620,584
Tripoli	43,257	215,216	26,069	338,188	19,982	199,854
Diatomaceous earth [b]	2,721	26,337	3,033	31,368	2,965	24,947
	245,095	974,202	704,229	1,882,767	193,643	1,104,715

[a] Includes only finely ground material. Figures probably incomplete.

[b] Excludes California product used for filters and as insulating and fireproofing material.

IMPORTS AND EXPORTS.

No imports or exports are reported.

SILVER.

[See under Gold and silver.[

SLATE.

PRODUCTION.

Slate sold in the United States, 1913–1918, by uses.

Year.	Roofing slate.			Mill stock.			Other uses (value).	Total value.
	Number of squares (100 square feet).	Value.	Average price per square.	Quantity (square feet).	Value.	Average price per square foot.		
1913	1,113,944	$4,461,062	$4.00	6,312,011	$1,233,838	$0.195	$480,576	$6,175,476
1914	1,019,553	4,160,832	4.08	5,361,925	977,930	.182	568,025	5,706,787
1915	967,880	3,746,334	3.87	4,576,112	819,672	.179	392,909	4,958,915
1916	835,873	3,408,934	4.08	5,782,842	1,177,260	.20	752,643	5,338,837
1917	703,667	3,411,740	4.85	5,478,151	1,277,249	.23	[a] 1,060,977	5,749,966
1918	379,817	2,219,131	5.84	4,841,133	1,498,164	.31	[a] 321,475	[b] 4,038,770

[a] Includes, in 1917, 4,378,490 school slates, valued at $48,828, and 2,650,563 square feet of blackboard material, valued at $413,163; in 1918, 1,244,740 school slates, valued at $17,016, and 1,607,849 square feet of blackboard material, valued at $264,921, and 89,074 square feet of billiard-table material, valued at $33,502, and excludes value of slate granules.

[b] Exclusive of value of slate granules.

Slate sold in the United States, 1913–1918, by States.

State.	1913	1914	1915	1916	1917	1918
California				(a)	(a)	(a)
Georgia	(a)					
Maine	$323,998	$277,419	(a)	(a)	(a)	(a)
Maryland	83,993	77,391	$91,277	$71,737	$67,938	$42,113
New Jersey	(a)	(a)	(a)	(a)	(a)	(a)
New York	144,882	112,776	127,603	21,345	55,207	[b] 11,383
Pennsylvania	3,733,581	3,609,959	3,044,269	3,124,743	3,306,704	2,304,647
Tennessee					(a)	(a)
Utah		(a)	(a)	(a)	(a)	(c)
Vermont	1,697,820	1,414,247	1,234,891	1,607,901	1,858,307	[b] 1,279,987
Virginia	175,830	204,139	210,612	165,483	135,380	109,723
Undistributed [d]	15,372	10,856	250,263	347,628	326,430	290,917
	6,175,476	5,706,787	4,958,915	5,338,837	5,749,966	[b] 4,038,770

[a] Included in "Undistributed."

[b] Exclusive of value of slate granules.

[c] Slate granules only produced and value excluded from total for United States.

[d] 1913: Georgia and New Jersey; 1914: New Jersey and Utah; 1915: Maine, New Jersey, and Utah; 1916: California, Maine, New Jersey, and Utah; 1917: California, Maine, New Jersey, Tennessee, and Utah; 1918: California, Maine, New Jersey, and Tennessee.

IMPORTS.

Imports of slate are negligible, being valued at $321 in 1918, as compared with $1,024 in 1917.

EXPORTS.

Roofing slate exported from the United States, 1913–1918.

1913	$226,413	1916	$27,630
1914	139,125	1917	27,113
1915	46,137	1918	65,224

Slate other than roofing exported in 1917 and 1918, by uses.[a]

Use.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
School slates .... cases[b]	22,682	$136,122	16,521	$111,680
Slate pencils .... do	5,000	33,060	3,450	35,945
Electrical slate .... square feet	28,136	21,059	35,883	35,478
Blackboards .... do	60,390	11,925	12,287	2,590
Billiard tables .... do	6,811	1,202	4,478	1,345
Structural .... do	4,040	1,222	1,285	525
	....	204,590	....	187,563

[a] Figures compiled from statements of manufacturers.
[b] Cases weigh from 130 to 165 pounds each; average is 135 pounds.

SOAPSTONE.

[See under Talc and soapstone.]

SODIUM AND SODIUM COMPOUNDS.

PRODUCTION.

Sodium and sodium compounds produced in the United States in 1917 and 1918, by varieties.

Variety.	1917		1918	
	Quantity (short tons).	Value.	Quantity. (short tons).	Value.
Sodium (metal)	(a)	(a)	264	$153,437
Sodium acetate	1,049	$225,828	2,622	460,783
Sodium benzoate	....	....	203	886,058
Sodium bicarbonate	119,177	4,029,499	118,535	3,293,153
Sodium bichromate and sodium chromate	22,446	9,045,133	28,334	9,868,118
Sodium bisulphite and sodium sulphite	13,707	300,668	16,362	478,482
Sodium bromide	....	....	574	438,730
Sodium carbonate:				
Soda ash	1,390,625	38,028,000	1,390,628	35,635,520
Monohydrate and sesquicarbonate	55,035	1,262,875	22,678	482,958
Sal soda	77,939	1,698,520	82,465	2,020,271
Sodium chlorate and sodium perborate	2,915	1,333,426	2,413	1,004,250
Sodium chloride (common salt):				
Salt in brine	2,890,588	1,083,586	2,830,600	1,245,265
Rock salt	1,605,025	3,897,595	1,683,941	5,684,661
Evaporated salt	2,482,564	14,959,261	2,724,203	20,010,435
Sodium cyanide, sodium iodide, and sodium peroxide	9,694	6,133,000	9,086	5,427,240
Sodium ferrocyanide	4,173	2,577,667	4,525	2,690,110
Sodium fluoride, acid sodium fluoride, and sodium fluosilicate (silicofluoride)	1,424	397,305	1,228	281,264
Sodium hydroxide (caustic soda)	488,056	29,402,689	513,363	31,854,470
Sodium nitrite	861	480,145	1,701	609,779
Sodium phosphate (including all sodium phosphates)	13,305	711,283	15,620	1,427,947
Sodium silicate	254,011	3,317,547	317,161	5,870,973
Sodium sulphate:				
Salt cake	183,909	2,987,641	141,054	2,844,897
Glauber's salt	47,757	732,403	50,715	1,041,070
Niter cake	387,821	780,278	143,155	595,660
Sodium sulphide	49,494	1,905,473	43,490	2,293,304
Sodium tetraborate (borax)	28,309	3,805,711	26,673	3,909,565
Sodium thiosulphate (hyposulphite)	26,598	717,924	26,868	1,051,623
Miscellaneous sodium compounds	4,563	2,062,300	381	1,122,552
	10,161,045	131,875,757	10,198,842	142,682,575

[a] Included under "Miscellaneous sodium compounds."

Sodium salts derived from natural sources in 1917 and 1918, by varieties.

Salt.	1917		1918	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Sodium chloride (common salt):				
Salt in brine	2,890,588	$1,083,586	2,830,600	$1,245,265
Rock salt	1,605,025	3,897,595	1,683,941	5,684,661
Evaporated salt	2,482,564	14,959,261	2,724,203	20,010,435
Sodium carbonate, sodium bicarbonate, and sodium sulphate	21,743	895,602	24,053	992,788
	6,999,920	20,836,044	7,262,797	27,983,149

Crude borate materials produced in the United States, 1909–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1909	41,434	$1,534,365	1914	62,400	$1,464,400
1910	42,357	1,201,842	1915	67,003	1,677,099
1911	53,330	1,569,151	1916	103,525	2,409,459
1912	42,315	1,127,813	1917	108,875	3,609,632
1913	58,061	1,491,530	1918	88,794	2,263,230

IMPORTS.

Sodium salts imported for consumption in the United States, 1917 and 1918, by varieties.

Salt.	1917		1918	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Sodium arsenate	23,296	$2,404	35	$88
Sodium benzoate	42,561	197,284	54,150	11,469
Sodium bicarbonate [a]	35,737	1,660	12,383	629
Sodium carbonate:				
Soda ash	2,063,571	70,080	1,445	29
Monohydrate and sesquicarbonate	45,650	1,179	44,800	1,281
Sal soda	100	5	25	2
Sodium chlorate	33,600	1,080	44,810	8,066
Sodium chloride (common salt)	129,844,300	280,135	80,580,700	281,468
Sodium chromate and sodium bichromate	22,025	4,075	5,102	1,184
Sodium cyanide	1,622,118	826,052	69,279	12,615
Sodium ferrocyanide (yellow prussiate of sodium)	22,048	13,454	271,063	98,505
Sodium hydroxide or caustic soda	146,236	17,773	2,002	193
Sodium nitrate or Chilean nitrate	3,456,780,000	60,727,100	4,138,758,400	90,216,935
Sodium nitrite	8,767,415	349,111	2,857,631	289,182
Sodium phosphate	437	180	....	....
Sodium silicate	936,576	15,963	464,461	9,902
Sodium sulphate, crude, or salt cake and niter cake	984,000	8,583	138,880	947
Sodium sulphide	288,292	5,104	112,821	4,673
Sodium sulphite	1,268	30	30,450	1,287
Sodium tetraborate or refined borax	110	7	2	1
Sodium thiosulphate or sodium hyposulphite	5,840	5,748	1,120	975
	3,601,665,180	62,527,007	4,223,449,559	90,939,431

[a] Or supercarbonate, or saleratus, and other salts containing 50 per cent or more of sodium bicarbonate.

EXPORTS.

Domestic sodium salts exported, 1914–1918.

Year.	Value.	Year.	Value.
1914	[a]$1,320,963	1917	$23,384,969
1915	7,725,034	1918	22,291,735
1916	17,571,439		

[a] Figures cover six months, July 1 to December 31, 1914.

Domestic sodium salts exported, 1917 and 1918, by varieties.

Salt.	1917		1918	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
All soda		[a] $9,322,233		
Sodium carbonate:				
Soda ash	[b] 49,210	[b] 2,884,569	119,217	$7,805,550
Sal soda	[b] 3,718	[b] 97,772	6,358	213,865
Sodium chloride (common salt)	113,993	1,000,773	136,783	1,677,577
Sodium hydroxide	[b] 44,997	[b] 5,832,598	48,689	5,602,813
Sodium silicate	[b] 7,275	[b] 216,828	14,125	404,796
All other sodium salts		[b] 4,030,196		6,587,134
		23,384,969		22,291,735

[a] Figures cover six months, January to June.
[b] Figures cover six months, July to December.

Foreign sodium salts reexported, 1915–1918.

Year.	Sodium chloride (common salt).		Sodium cyanide.		Sodium nitrate.		All other sodium salts.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Value.
1915	52	$31,841	949	$347,079	25,472	$1,123,761	$40,358
1916	7,448	61,525	111	58,265	60,079	3,432,273	193,086
1917	1,900	21,830	138	115,067	78,152	5,367,281	25,632
1918	723	13,903	(a)	145	61,271	5,204,413	73,402

[a] 125 pounds.

STEEL.

[See under Iron ore, pig iron, and steel.]

STONE.

PRODUCTION.

Value of the different kinds of stone produced and sold in the United States, 1909–1918.

Year.	Granite.	Basalt and related rocks (trap rock).[a]	Sandstone.	Marble.	Limestone.	Miscellaneous.[b]	Total.
1909	$19,581,597	$5,133,842	$8,010,454	$6,548,905	$32,070,401	....	$71,345,199
1910	20,541,967	6,452,141	7,930,019	6,992,779	34,603,678	....	76,520,584
1911	21,194,228	6,739,141	7,730,868	7,546,718	33,897,612	....	77,108,567
1912	19,223,302	7,560,049	6,893,611	7,786,458	36,729,800	....	78,193,220
1913	20,733,217	9,134,494	7,248,965	7,870,890	38,745,429	....	83,732,995
1914	20,160,730	7,865,998	7,501,808	8,121,412	33,894,155	....	77,544,103
1915	17,864,439	8,489,222	6,095,800	6,916,025	35,229,866	....	74,595,352
1916	17,456,838	7,666,297	5,603,778	7,033,171	41,309,599	....	79,069,683
1917	15,544,957	7,570,885	5,512,421	6,330,387	46,263,379	$903,642	82,215,371
1918	14,466,423	7,782,280	4,529,298	5,496,389	49,453,006	973,034	82,700,430

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[a] The term "trap rock" has been variously interpreted and in some localities has been made to include a number of widely different rocks. It is here replaced by the title "basalt and related rocks."

[b] Includes mica schist used for furnace lining, conglomerate, argillite, and various light volcanic rocks used mainly for crushed stone, which can not be properly classified in any of the main groups.

Stone sold in the United States, 1917 and 1918, by uses.

Use.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Building stone ....cubic feet..	17,467,920	$12,102,914	8,616,900	$7,454,973
Approximate equivalent in short tons..........	1,469,120	....	719,200	....
Monumental stone..........cubic feet..	4,058,626	8,102,493	4,072,343	9,912,167
Approximate equivalent in short tons..........	341,420	....	343,100	....
Paving blocks..........number..	48,907,670	2,732,434	28,516,910	1,714,011
Approximate equivalent in short tons..........	511,060	....	298,650	....
Curbing..........cubic feet..	2,367,163	1,402,980	951,650	661,188
Approximate equivalent in short tons..........	196,800	....	80,570	....
Flagging..........cubic feet..	1,043,738	356,327	798,934	373,729
Approximate equivalent in short tons..........	86,390	....	65,900	....
Rubble..........short tons..	915,646	864,321	482,365	635,895
Riprap..........do....	2,938,877	2,208,373	2,273,852	1,923,154
Crushed stone..........do....	40,285,377	29,065,509	29,373,342	27,951,393
Furnace flux [a]..........long tons..	25,574,146	18,679,213	23,917,040	23,512,635
Equivalent in short tons..........	28,640,044	....	26,787,065	....
Refractory stone [b]..........short tons..	1,573,573	1,607,743	1,825,183	2,363,154
Manufacturing industries [a]..........do....	5,446,558	4,070,351	4,838,108	4,194,013
Other uses..........do....	1,175,070	1,023,013	1,476,005	2,004,118
Total (quantities, approximate in short tons)..	83,574,900	82,215,671	68,563,360	82,700,430

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[a] Limestone alone in 1917; limestone and marble in 1918.

[b] Ganister, mica schist, and dolomite.

IMPORTS.

Stone imported for consumption in the United States, 1916–1918.

Kind.	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Marble:						
In blocks, rough, etc.......cubic feet..	350,941	$529,125	267,250	$428,396	96,478	$192,641
Sawed..........................do....	51	246	9	25		
Slabs or paving tiles......square feet..	70,545	15,221	124,935	27,884	26,118	5,304
All other manufactures...............		122,145		87,177		28,798
Mosaic cubes:						
Loose...............................		22,285		13,434		5,508
		689,022		556,916		232,251
Onyx:						
In blocks, rough, etc.......cubic feet..	9,071	32,282	6,935	22,439	1,398	3,046
Slabs or paving tiles......square feet..			5,976	1,595		
All other manufactures...............		2,077		472		133
		34,359		24,506		3,179
Granite:						
Dressed.............................		66,331		25,119		1,328
Rough....................cubic feet..	23,773	9,366	18,982	9,923	18,473	9,653
		75,697		35,042		10,981
Stone (other):						
Dressed.............................		11,456		15,296		5,060
Rough (monumental or building stone.................. cubic feet..	95,005	66,337	53,537	40,330	11,995	12,716
Rough (other).......................		82,496		9,385		4,390
		160,289		65,011		22,166
Grand total.....................		959,367		681,475		268,577

EXPORTS.

Stone exported from the United States, 1913–1918.

Kind.	1913	1914	1915	1916	1917	1918
Marble and stone, unmanufactured..................	$606,745	$559,556	$400,510	$403,303	$572,097	$552,261
All others, manufactured......	1,250,147	803,686	635,614	1,077,447	1,108,185	1,208,164
	1,856,892	1,363,242	1,036,124	1,480,750	1,680,282	1,760,425

STRONTIUM.

PRODUCTION.

Domestic strontium ore marketed in the United States, 1916–1918.

Year.	Quantity (short tons)	Value.
1916..	250	$3,650
1917..	4,035	87,700
1918..	400	20,000

The Geological Survey has no record of the production of domestic strontium ore prior to 1916.

IMPORTS.

Value of oxide and protoxide of strontium and strontianite, mineral carbonate of strontium imported for consumption in the United States, 1913–1918.

Year.	Value.	Year.	Value.
1913	$2,284	1916	$11,049
1914	1,016	1917	23,216
1915	6,411	1918	2,459

EXPORTS.

No exports of strontium ore have been reported.

SULPHUR.

PRODUCTION.

Sulphur produced and shipped in the United States, 1909–1918.

Year.	Mined.	Shipped.		Year.	Mined.	Shipped.	
	Quantity (long tons).	Quantity (long tons).	Approximate value.		Quantity (long tons).	Quantity (long tons).	Approximate value.
1909	273,983	258,203	$4,782,000	1914	417,690	341,985	$6,214,000
1910	247,060	250,919	4,522,000	1915	520,582	293,803	4,959,000
1911	205,066	253,795	4,573,000	1916	649,683	766,835	12,246,000
1912	787,735	305,390	5,289,000	1917	1,134,412	1,120,378	23,987,000
1913	491,080	319,333	5,617,000	1918	1,353,525	1,266,709	27,868,000

IMPORTS.

Sulphur imported and entered for consumption in the United States, 1913–1918.

Year.	Crude.		Flowers of sulphur.		Refined.		All other.[a]		Total.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1913	15,122	$286,209	5,899	$115,574	1,234	$29,091	350	$17,690	22,605	$448,564
1914	23,610	398,984	621	17,214	1,800	47,568	104	14,171	26,135	477,937
1915	24,647	405,990	647	23,146	988	30,335	85	12,987	26,367	472,458
1916	21,289	358,416	425	18,408	455	15,020	66	12,940	22,235	404,784
1917	973	20,176	....	....	....	....	42	9,164	1,015	29,340
1918	55	1,692	....	....	....	....	27	7,850	82	9,542

[a] Includes sulphur lac and other grades not otherwise provided for, but not pyrite.

EXPORTS.

Sulphur exported from the United States, 1909–1918.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1909	37,142	$736,928	1914	98,163	$1,807,324
1910	30,742	552,941	1915	37,312	724,679
1911	28,103	545,420	1916	128,755	2,505,857
1912	57,736	1,076,414	1917	152,736	3,500,819
1913	89,221	1,599,761	1918	131,092	3,626,638

TALC AND SOAPSTONE.

TALC.

PRODUCTION.

Talc produced and sold in the United States, 1913–1918, by classes.

Year.	Rough (crude).		Manufactured into pencils and blanks.[a]		Ground.[b]		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	2,454	$11,597	138	$36,272	146,679	$1,232,151	149,271	$1,280,020
1914	2,634	17,088	698	59,380	147,756	1,264,406	151,088	1,340,874
1915	8,235	58,867	39	11,941	158,062	1,330,389	166,336	1,401,197
1916	11,299	106,928	828	102,674	181,182	1,553,240	193,309	1,762,842
1917	12,269	68,440	5,781	176,404	180,563	1,644,828	198,613	1,889,672
1918	13,263	106,228	945	114,002	177,269	1,869,730	191,477	2,089,960

[a] Includes slate pencils and metal workers' crayons and blanks used in making acetylene burners and other objects.

[b] For foundry facings, filler for paper, paint, and rubber goods, toilet powder, foot ease, lubricators for dressing skins and leather, etc.

IMPORTS.

Talc imported for consumption in the United States, 1913–1918.

Year.	Crude and unground steatite and French chalk.[a]			Ground talc, or steatite, cut, powdered, washed, or pulverized.[b]			Total.	
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.
1913	(c)	(c)	....	(c)	(c)	....	13,770	$137,680
1914	(c)	(c)	....	(c)	(c)	....	15,734	177,321
1915	2,117	$12,967	$6.12	15,952	$186,873	$11.71	18,069	199,840
1916	2,027	12,645	6.24	16,855	218,230	12.95	18,882	230,875
1917	2,452	10,710	4.37	16,157	258,787	16.02	18,609	269,497
1918	1,434	9,253	6.45	12,785	251,323	19.73	14,169	260,576

[a] Duty free. [b] 15 per cent duty. [c] Not separately classified.

EXPORTS.

No exports of talc are reported.

SOAPSTONE.

PRODUCTION.

Soapstone produced and sold in the United States, 1913–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1913	26,562	$628,077	1916	19,652	$490,961
1914	21,208	524,213	1917	20,235	(a)
1915	20,555	490,385	1918	16,830	591,059

[a] Unpublished to avoid revealing value of business of one firm which constitutes bulk of output of three producers.

IMPORTS AND EXPORTS.

Imports and exports of soapstone are not separately reported.

TELLURIUM.

Only one refiner, the Raritan Copper Works, reported a production of tellurium in 1918. There continues to be little market for tellurium and a correspondingly small production. Tellurium is a by-product from the electrolytic refining of copper.

Imports and exports of tellurium are not reported.

THORIUM MINERALS.

SUPPLY.

Monazite sand produced in the United States and monazite sand and thorium nitrate imported for consumption, 1909–1918.

Year.	Monazite sand produced in the United States.		Imports of monazite sand.		Imports of thorium nitrate.		Price per pound of thorium nitrate.
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	
1909	541,931	$65,032	69,988	$8,324	127,833	$236,057	$3.87
1910	99,301	12,006	453,554	39,699	124,808	219,615	3.10
1911			705,149	60,542	121,111	238,841	3.00
1912			556,959	47,334	117,485	225,386	3.00
1913			817,810	65,848	119,044	230,628	2.73
1914			770,842	61,595	101,927	239,376	2.98
1915	36,000	3,600	1,873,971	161,456	67,247	170,268	[a]4.50
1916	37,872	3,400	2,436,197	188,383	909	3,884	[a]6.25
1917	22,000	1,760	5,828,270	355,017	1,188	2,359	[a]8.00
1918			2,994,515	204,661			[a]8.00

[a] The figures for 1915 to 1918 were kindly furnished by Dr. Hugo Lieber, 23 East Twenty-sixth Street, New York City, and ranged as follows: 1915, $3.75 to $6; 1916, $4.75 to $8.50; 1917, $7 to $8; and 1918, $8 to $8.25.

EXPORTS.

No exports of thorium minerals are reported.

TIN.

PRODUCTION.

The metallic tin obtainable from ore mined in the United States in 1918 amounted to 69 short tons. As in the past, practically all of the ore was won in Alaska.

WORLD'S PRODUCTION.

World's production of metallic tin, 1913–1918, in metric tons.

[Metal obtainable by smelting from concentrates.]

Country.	1913	1914	1915	1916	1917	1918
Federated Malay States	50,930	49,820	47,520	44,570	40,470	37,970
British Protected Malay States	1,800	2,700	4,170	4,450	4,500	4,500
Bolivia	26,760	22,360	21,900	21,330	28,320	29,770
Banca	15,940	14,630	13,660	14,460	13,540	11,000
Billiton and Singkep	5,300	6,090	6,760	6,780	7,300	9,200
China	8,390	7,120	8,000	7,630	11,800	8,500
Siam	6,660	6,740	8,520	8,960	8,600	8,600
Nigeria	2,950	4,590	4,630	5,150	7,070	7,000
Australia	8,160	5,520	5,680	5,550	4,970	4,900
Cornwall	5,370	5,140	5,060	4,770	4,000	4,000
Union of South Africa	2,050	2,000	2,050	1,900	1,540	1,370
Other countries	1,400	1,500	1,500	1,700	1,800	2,000
	135,710	128,210	129,450	127,250	133,910	128,810

IMPORTS.

Tin imported into the United States in 1917 and 1918, by countries, in short tons.

[Metallic tin and tin obtainable from ore.]

Source.	1917	1918	Source.	1917	1918
Straits Settlements	26,598	36,067	Australia	2,872	3,787
England	19,840	9,038	China	2,461	1,603
Dutch East Indies	15,843	10,670	Other countries	603	2,199
Bolivia (tin in concentrate)	5,700	11,600			
Hongkong	3,601	7,890		77,518	82,854

Tin imported as metal and entered for consumption in the United States, 1909–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1909	47,662	$27,558,546	1914	47,530	$32,881,619
1910	52,528	33,913,255	1915	57,792	38,736,909
1911	53,527	43,346,394	1916	69,035	51,802,232
1912	58,016	50,372,478	1917	72,166	63,860,340
1913	52,329	46,927,213	1918	71,254	93,144,218

Tin ore imported into the United States, 1916–1918.

Year.	Quantity (short tons).	Value.
1916	9,304	$4,036,821
1917	9,054	4,743,099
1918	18,394	11,444,401

Imports of tin ore were not separately listed before 1916 and, except possibly for 1915, were negligible, as no foreign tin ores were smelted before 1916.

EXPORTS.

Exports of tin ore are insignificant and are not recorded.

PRICES.

Average monthly prices, in cents per pound, of Straits tin in New York, in 1918.[a]

Month.	Prompt.[b]	Futures.[c]	Month.	Prompt.[b]	Futures.[c]
January	84.00	70.00	July	98.00	85.00
February	85.00	72.00	August	90.00	80.00
March	87.00	76.00	September	80.00	73.00
April	90.00	83.00	October	80.00	[d] 72.50
May	105.00	93.00	November	74.00	[d] 72.50
June	97.00	82.00	December	71.50	[d] 72.50

[a] American Metal Market and Daily Iron and Steel Report, Vol. 26, Feb. 5, 1919.

[b] Approximate averages based on sales of Straits and other grades of pure tin for prompt delivery, for the most part in small lots.

[c] Approximate averages based on sales of Straits tin for shipment from Singapore. The prices for Straits for many months were below those paid for Chinese and other grades on which the shipping restrictions were not so great.

[d] On October 3 all licenses to import tin, except to U. S. Steel Products Co., were refused on orders in accordance with inter-allied agreement. The price of 72½ cents represents the average cost to U. S. Steel Products Co. of tin imported by them under this agreement.

Average yearly prices, in cents per pound, of Straits tin in New York, 1909–1918.[1]

1909	29.76	1913	44.32	1916	43.48
1910	34.27	1914	35.70	1917	61.65
1911	42.68	1915	38.66	1918	86.80
1912	46.43				

TITANIUM.

PRODUCTION.

Rutile, titanium dioxide (TiO_2), and ilmenite, titanium iron oxide ($TiFeO_3$), were produced in this country in 1918 by the American Rutile Co., at Roseland, Nelson County, Va. The company sold 261 short tons of rutile concentrates, carrying 95 per cent of TiO_2, valued at $39,150, and 444 tons of ilmenite concentrates, carrying 55 per cent of TiO_2, valued at $11,100. The ilmenite is obtained as a by-product of the rutile.

At Pablo Beach, Fla., Buckman & Pritchard (Inc.) built a large new plant to separate rutile, ilmenite, monazite, and zircon from the beach sand. No rutile was sold during the year, but about 1,200 tons of ilmenite was produced and shipped.

TRIPOLI.

[See under Abrasive materials.]

TUNGSTEN.

SUPPLY.

Supplies of tungsten ores in the United States, 1912–1918, in short tons.

Year.	Production.	Imports for consumption.			Exports.[a]		Apparent consumption.[b]
		Ore.	Tungsten and ferrotungsten.	Estimated equivalent in ore carrying 60 per cent of tungsten trioxide.[c]	Tungsten and ferrotungsten.	Estimated equivalent in ore carrying 60 per cent of tungsten trioxide.	
1912	1,330	824	323	1,620			2,950
1913	1,537	449	740	2,151			3,688
1914	990	299	218	814			1,804
1915	2,332	1,776	8	1,942			4,274
1916	5,923	3,973	43	4,401	287	580	9,744
1917	6,144	4,876	1	5,284	1,162	2,420	9,008
1918	5,061	11,750		12,729	616	1,265	[d] 10,525

[a] No record of tungsten ore exported is at hand, although it is known that some has been shipped abroad.

[b] Production plus imports minus estimated equivalent in ore of the exports of tungsten and ferrotungsten. The apparent consumption is at best only an approximation.

[c] These items include the ore (considered as carrying 65 per cent of tungsten trioxide) and the tungsten and ferrotungsten (considered as equivalent to 2½ times their weight in ore carrying 60 per cent of tungsten trioxide). Chinese ore imported has been considered as 67.5 per cent of tungsten trioxide.

[d] In arriving at this figure, 6,000 tons estimated to be on hand at the close of 1918 has been deducted.

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[1] Metal Statistics, 1918, p. 273.

PRODUCTION.

Concentrated tungsten ores (carrying 60 per cent tungsten trioxide) produced in the United States, 1909–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity. (short tons).	Value.
1909	1,619	$614,370	1914	990	$435,000
1910	1,821	832,992	1915	2,332	4,100,000
1911	1,139	407,985	1916	5,923	12,074,000
1912	1,330	502,158	1917	6,144	6,783,000
1913	1,537	672,118	1918	5,061	7,049,300

Concentrated tungsten ores (carrying 60 per cent tungsten trioxide) produced in the United States, 1916–1918, by States, in short tons.

State.	1916	1917	1918	State.	1916	1917	1918
Alaska	47	32	14	Connecticut	41	59	30
Arizona	218	150	213	Missouri			
California	2,171	2,781	1,791	Montana			
Colorado	2,401	2,707	1,910	Oregon			
Idaho	101	2	....	Utah			
Nevada	689	143	898	Washington			
New Mexico	16	(a)	4				
South Dakota	239	270	201		5,923	6,144	5,061

a Less than 1 ton.

World's production of tungsten ore, 1913–1918, in metric tons of concentrates containing 60 per cent of tungsten trioxide.

Area.	1913	1914	1915	1916	1917	1918
Asia:						
Japan	257	204	389	730	763	629
Chosen (Korea)	....	....	67	555	900	1,097
China	....	18	35	109	1,361	10,187
Tonkin	127	162	333	343	433	450
Burma and Shan States	1,572	2,166	2,464	3,464	4,226	4,138
Siam	280	273	432	530	726	185
Unfederated Malay States	114	172	159	317	334	1,156
Federated Malay States	248	288	329	524	721	362
Billiton and Singkep	6	1	6	47	8	55
India (excluding Burma)	....	....	....	46	68	44
	2,604	3,284	4,214	6,665	9,540	18,303
Australia:						
Queensland	533	401	642	456	471	357
Northern Territory	32	45	36	137	252	275
New South Wales	200	221	99	313	268	279
Victoria	1	....	....	1	....	....
South Australia	....	....	....	1	....	....
Tasmania	81	56	112	144	286	440
Western Australia	1	1	....	....	....	....
	848	724	889	1,052	1,277	1,351
Oceania: New Zealand	262	242	230	315	235	170
South America:						
Chile	....	....	....	9	2	....
Argentina	575	437	169	854	1,056	613
Bolivia	297	290	859	3,288	4,215	3,703
Peru	324	218	413	532	427	251
Brazil	....	....	....	5	....	....
	1,196	940	1,441	4,688	5,700	4,567

World's production of tungsten ore, 1913–1918, in metric tons of concentrates containing 60 per cent of tungsten trioxide—Continued.

Area.	1913	1914	1915	1916	1917	1918
North America:						
United States (exclusive of Alaska)	1,394	898	2,116	5,330	5,545	4,578
Alaska				43	29	13
Mexico			140	159	308	239
Southeastern Canada	11					15
	1,405	898	2,256	5,532	5,882	4,845
Europe:						
Norway	3	5		1	1	
Sweden						3
England	197	222	360	407	245	308
France	160	145	126	162	261	212
Portugal	1,126	667	953	1,418	1,580	1,150
Spain	169	135	189	425	446	579
Italy				5	1	
Germany	96	108	193	330	300	300
Austria	52	57	14	10	10	10
Russia				33	33	33
	1,803	1,339	1,835	2,791	2,877	2,595
Africa: South Africa	5		1	3	12	34
	8,123	7,427	10,866	21,046	25,523	31,865

IMPORTS.

Tungsten-bearing ore imported into the United States in 1918, by countries.[a]

[General imports.]

Country.[a]	Quantity (short tons).	Value.	Country.[a]	Quantity (short tons).	Value.
Argentina	536	$730,722	Japan	1,362	$1,700,332
Bolivia	88	122,357	Mexico	264	224,247
Brazil	3	4,177	Panama	37	40,614
Canada	56	115,863	Peru	1,827	1,488,516
Chile	1,250	1,209,864	Portugal	27	17,760
China	2,385	2,068,636	Other British East Indies	19	13,071
Colombia	56	65,124	Salvador	40	60,042
Costa Rica	18	19,081	Siam	11	8,583
Ecuador	6	9,979			
France	29	3,400		11,609	11,413,414
Hongkong	3,595	3,511,046			

[a] The ore from France probably originated in Portugal; that from Costa Rica, Panama, Salvador, Bolivia, Chile, Colombia, Ecuador, and most of that from Peru is probably from Bolivia; that from China, practically all that from Hongkong, and half of that from Japan is probably from China.

The tenor of the imported ore is not accurately known, but it probably averaged more nearly 65 per cent tungsten trioxide than 60 per cent. Much of the Chinese ore carried 70 per cent tungsten trioxide.

EXPORTS.

No exports of tungsten ores are reported, although it is known that some has been shipped abroad.

PRICES.

The prices of tungsten ores were fairly steady during the greater part of 1918. Scheelite that was free from phosphorus, sulphur, and other harmful impurities brought about $25 a unit most of the year. The other minerals brought from $18 to $25. The price of impure ores was always a matter of bargaining. Toward the end of the summer and in the fall the demand was very heavy, owing to the huge orders of the Government for war materials. Upon the signing of the armistice, on November 11, orders were canceled, the demand slowed down, and prices fell accordingly. At the end of the year wolframite of good quality that carried more than 60 per cent of tungsten trioxide was offered in New York for $12 a unit.

URANIUM AND VANADIUM ORES.

PRODUCTION.

The output of uranium and vanadium ores in 1918 amounted to about 18,860 short tons, containing 27.1 grams of radium (Ra), 89.5 tons of uranium (105.5 tons of U_3O_8), and 276 tons of vanadium. Any value given to the output must be arbitrary and open to question, for the larger part of the uranium ore was produced by companies that themselves used the ore, and the vanadium ore was produced only by the Primos Chemical Co., which also reduced the ore, and by the Colorado Vanadium Co., which sold its ore to the Primos Chemical Co. Although there is a market for carnotite ore ($K_2O.2UO_3.V_2O_5.8H_2O$), which gives a basis for estimating the value of other similar ores, there is none for vanadium ore. The approximate value, as ore, was probably about $957,000. More than 21.7 grams of radium in various salts was isolated during the year.

IMPORTS.

Uranium salts and oxide, including some radium salts, imported for consumption, 1913–1918.

Year.	Value.	Year.	Value.
1913	$34,319	1916	$5,065
1914	63,055	1917	2,930
1915	17,288	1918	[a] 274

[a] Radium salts only. In addition, 157 pounds of "uranium-radium steel-hardening ores," valued at $4,840, was imported.

EXPORTS.

About 3 grams of elemental radium in salts is known to have been exported during 1918.

ZINC.

SUPPLY.

Supplies of primary zinc in the United States, 1913–1918, in short tons.

	1913	1914	1915	1916	1917	1918
Supply:						
Stock, Jan. 1—						
In bonded warehouses	48	....	111	32	90	32
At smelters	4,474	40,659	19,984	14,221	17,508	53,689
Production—						
From domestic ore	337,252	343,418	458,135	564,338	584,597	492,405
From foreign ore	9,424	9,631	31,384	104,005	84,976	25,522
Imports	6,100	880	904	684	257	35
Total available	357,298	394,588	510,518	683,280	687,428	571,683
Withdrawn:						
Exports, foreign, from warehouse	6,027	5,580	12,775	43,230	64,680	20,069
Exports, foreign, under drawback	7,459	4,128	32	....	1,588	6,337
Exports, domestic	7,783	64,802	118,603	163,135	153,796	80,244
Stock, Dec. 31—						
In bonded warehouses	....	111	32	90	32	....
At smelters	40,659	19,984	14,221	17,508	53,689	41,241
Total withdrawn	61,928	94,605	145,663	223,963	273,785	147,891
Consumption	295,370	299,983	364,855	459,317	413,643	423,792

PRODUCTION.

PRIMARY ZINC.

Primary zinc apportioned according to source of ore, 1913–1918, in short tons.

Source.	1913	1914	1915	1916	1917	1918
United States	337,252	343,418	458,135	564,338	584,597	492,405
Foreign:						
Canada	1,424	4,538	5,103	24,376	6,787	8,700
Mexico	6,205	5,093	13,943	20,694	40,360	14,043
Europe	1,175	....	1,073	12,379	11,689	113
Africa	....	....	....	2,016	....	....
Asia	620	....	1,030	1,905	....	....
Australia	....	....	10,235	41,958	26,140	1,780
Other countries	....	....	....	677	....	886
Total foreign	9,424	9,631	31,384	104,005	84,976	25,522
Grand total	346,676	353,049	489,519	668,343	669,573	517,927

Primary zinc apportioned according to locality in which smelted, 1913–1918, in short tons.

Location of smelter.	1913	1914	1915	1916	1917	1918
Illinois	106,654	127,946	159,958	181,433	172,489	141,844
Kansas	74,106	44,510	101,423	141,286	76,048	29,149
Oklahoma	83,214	91,367	109,208	168,206	204,394	139,066
Other States	82,702	89,226	118,930	177,418	216,642	207,868
Total	346,676	353,049	489,519	668,343	669,573	517,927

Primary zinc produced in the United States from domestic ores, 1909–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1909	230,225	$24,864,300	1914	343,418	$35,029,000
1910	252,479	27,267,732	1915	458,135	113,617,000
1911	271,621	30,964,794	1916	564,338	151,243,000
1912	323,907	44,699,166	1917	584,597	119,258,000
1913	337,252	37,772,224	1918	492,405	89,618,000

SECONDARY ZINC.

Secondary zinc produced in the United States, 1913–1918, in short tons.

	1913	1914	1915	1916	1917	1918
Secondary zinc, redistilled	25,991	20,545	29,764	28,776	16,835	9,918
Secondary zinc, remelted	24,014	22,424	23,136	21,037	14,565	17,190
Secondary zinc recovered in alloys, excluding old brass remelted	3,743	3,914	5,300	2,600	4,800	11,082

IMPORTS.

Zinc ore imported into the United States in 1917 and 1918, by countries.

Source.	1917			1918		
	Ore (short tons).	Zinc content (short tons).	Value.	Ore (short tons).	Zinc content (short tons).	Value.
Canada	16,559	5,155	$338,668	14,987	5,173	$319,815
Mexico	145,358	45,697	2,837,211	53,348	18,426	1,202,035
Spain	14,778	6,083	260,922			
Italy	5,919	2,411	117,271			
Australia	27,730	12,503	753,598			
Other countries	1,251	625	66,388	2,567	1,210	52,119
	211,595	72,474	4,374,058	70,902	24,809	1,573,969

EXPORTS.

Zinc exported from the United States in 1917 and 1918, by classes.

Material.	1917		1918	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
DOMESTIC.				
Zinc ore	2,640,960	$63,043	123,000	$2,480
Zinc slabs	274,564,431	32,605,767	132,736,529	12,469,622
Zinc sheets	33,027,991	5,730,792	27,750,910	4,566,756
Zinc dross	26,604,969	2,126,909	31,631,364	2,238,913
Zinc manufactures		570,352		722,671
Brass, old, for remanufacturing	8,298,989	1,758,384	4,909,717	799,318
Brass, bars, plates, and sheets	328,346,666	101,521,426	30,989,717	9,522,934
Brass, articles made from		136,611,299		19,483,146
Cartridges		42,122,656		10,764,765
FOREIGN.				
Zinc, blocks, pigs, and old	129,360,631	12,429,356	40,138,715	3,532,968
Zinc dust	158,175	21,118	79,512	10,392
Zinc manufactures		50		
Brass, old, for remanufacturing	79,151	15,143		
Zinc used in articles exported with benefit of drawback	3,176,615	[a] 106,478	12,673,361	[a] 364,080

[a] Declared value of the zinc used in making the articles exported with benefit of drawback

Zinc and sheet zinc exported from the United States, 1916–1918, by destination, in short tons.

Destination.	1916		1917		1918	
	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.
Canada	10,216	708	9,427	4,026	6,996	1,052
Great Britain	60,529	18,847	71,555	24,739	28,334	6,908
Netherlands	9	....	....	112	....	....
France	51,810	19,465	41,901	21,596	25,140	10,373
Italy	14,081	3,933	10,593	9,873	6,130	1,537
Russia	11,786	124	8,238	2,443	....	....
Japan	882	....	1,360	....	5,287	....
Other countries	13,822	153	10,722	1,891	8,357	199
	163,135	43,230	153,796	64,680	80,244	20,069

PRICES.

[See statement on p. 26A.]

ZINC RESIDUUM.

[See under Manganiferous zinc residuum.]

ZIRCONIUM MINERALS.

No zirconium minerals were mined in the United States from 1912 to 1918, inclusive. Brazil is the world's main producer. The small imports of zirconium ore were not separately recorded prior to July 1, 1918. For the period, July to December, 1918, the imports of zirconium ore entered for consumption amounted to 3,216,659 pounds valued at $77,250. Exports are negligible and are not recorded.

STATE TABLES.

Value of mineral production, 1911 to 1918, by States.[a]

State.	1911	1912	1913	1914	1915	1916	1917	1918
Alabama	$28, 005, 785	$30, 641, 983	$34, 660, 545	$30, 879, 288	$29, 458, 157	$40, 922, 462	$65, 024, 838	$77, 795, 572
Alaska	20, 866, 122	22, 732, 947	19, 645, 498	19, 177, 051	32, 854, 011	48, 521, 513	40, 710, 655	28, 217, 407
Arizona	44, 503, 873	67, 497, 838	71, 429, 705	60, 420, 362	91, 552, 040	192, 622, 991	212, 615, 978	203, 992, 915
Arkansas	5, 864, 822	6, 258, 726	6, 780, 760	5, 787, 199	6, 558, 693	9, 508, 001	12, 061, 702	14, 081, 691
California	90, 620, 644	93, 219, 149	100, 791, 369	101, 013, 199	98, 198, 538	137, 284, 754	175, 399, 036	204, 673, 547
Colorado	52, 522, 416	58, 167, 399	54, 294, 281	52, 161, 660	64, 300, 026	77, 642, 778	80, 296, 218	79, 003, 928
Connecticut	3, 151, 588	3, 715, 480	3, 795, 297	3, 023, 192	3, 332, 330	3, 940, 676	3, 981, 203	3, 501, 460
Delaware	491, 657	425, 360	541, 542	288, 516	282, 292	336, 172	523, 991	372, 804
District of Columbia	277, 295	300, 336	246, 582	219, 680	205, 592	179, 436	204, 936	99, 221
Florida	10, 250, 228	10, 272, 594	10, 508, 016	8, 497, 688	4, 855, 690	5, 666, 785	7, 294, 467	7, 758, 732
Georgia	6, 172, 857	6, 306, 140	6, 525, 792	5, 704, 856	5, 094, 688	6, 779, 828	7, 650, 553	8, 312, 051
Idaho	19, 441, 545	21, 816, 390	24, 565, 826	24, 913, 223	33, 612, 194	49, 249, 134	55, 224, 026	36, 872, 270
Illinois	106, 275, 115	122, 966, 424	131, 701, 551	117, 005, 441	114, 112, 315	146, 359, 792	234, 735, 962	271, 244, 365
Indiana	37, 430, 187	42, 239, 193	46, 502, 633	42, 864, 267	41, 381, 456	56, 926, 558	83, 798, 648	96, 558, 784
Iowa	21, 112, 896	22, 900, 350	25, 602, 015	26, 287, 115	27, 048, 177	30, 210, 284	39, 336, 372	38, 742, 009
Kansas	24, 890, 043	25, 795, 267	26, 770, 302	25, 324, 085	28, 436, 446	41, 847, 955	106, 763, 055	147, 902, 091
Kentucky	19, 296, 614	22, 477, 530	26, 845, 579	26, 668, 474	27, 278, 627	40, 015, 935	77, 174, 802	104, 165, 945
Louisiana	12, 710, 958	15, 357, 841	21, 011, 828	21, 890, 025	18, 215, 847	28, 020, 543	37, 521, 872	54, 769, 225
Maine	4, 645, 630	3, 925, 526	4, 429, 584	3, 975, 890	3, 301, 907	3, 539, 481	3, 726, 121	3, 727, 107
Maryland	9, 386, 515	10, 851, 671	11, 292, 723	10, 587, 564	10, 581, 224	13, 335, 013	19, 617, 596	20, 866, 706
Massachusetts	6, 623, 077	6, 654, 514	7, 044, 529	6, 292, 833	6, 286, 860	6, 697, 444	7, 225, 750	7, 258, 088
Michigan	65, 275, 324	80, 062, 486	72, 143, 211	57, 743, 555	93, 938, 255	140, 666, 124	163, 997, 853	158, 312, 121
Minnesota	53, 395, 881	66, 672, 729	85, 814, 533	45, 680, 865	62, 391, 440	113, 662, 522	152, 490, 554	155, 412, 823
Mississippi	1, 052, 842	1, 242, 528	1, 143, 472	1, 104, 197	666, 143	890, 566	966, 135	925, 192
Missouri	50, 967, 074	57, 343, 307	53, 011, 088	47, 607, 593	74, 033, 623	102, 424, 953	105, 342, 678	76, 663, 995
Montana	53, 498, 194	71, 620, 873	69, 307, 056	54, 244, 889	89, 147, 138	142, 650, 179	123, 650, 330	139, 331, 507
Nebraska	1, 316, 168	1, 490, 582	1, 433, 718	1, 166, 787	1, 514, 171	3, 436, 774	7, 943, 729	6, 513, 422
Nevada	34, 501, 832	39, 111, 828	37, 842, 084	29, 984, 338	35, 991, 891	53, 510, 559	55, 408, 057	51, 080, 169
New Hampshire	1, 727, 645	1, 949, 876	2, 218, 925	2, 029, 835	1, 907, 949	1, 817, 723	1, 594, 584	1, 453, 921
New Jersey	34, 458, 865	37, 195, 940	35, 931, 191	31, 756, 503	38, 818, 422	59, 430, 705	57, 710, 181	49, 510, 290
New Mexico	8, 176, 229	14, 391, 355	17, 862, 369	18, 672, 919	25, 549, 161	37, 123, 501	43, 312, 947	40, 631, 024
New York	34, 317, 594	38, 431, 910	41, 709, 002	36, 420, 134	36, 414, 038	45, 619, 119	52, 123, 552	54, 080, 035
North Carolina	2, 793, 825	3, 368, 923	3, 739, 696	3, 519, 245	3, 365, 805	4, 595, 551	5, 246, 391	4, 973, 386
North Dakota	957, 425	1, 025, 741	1, 055, 676	1, 063, 540	985, 885	1, 283, 809	1, 749, 549	1, 823, 109
Ohio	97, 090, 284	111, 229, 656	121, 795, 892	101, 661, 384	105, 198, 086	145, 088, 485	217, 671, 746	246, 162, 215
Oklahoma	43, 036, 253	53, 614, 130	80, 168, 820	78, 744, 447	83, 672, 991	169, 556, 831	259, 134, 377	336, 857, 921
Oregon	3, 192, 679	2, 553, 549	3, 563, 919	3, 331, 132	3, 656, 562	4, 498, 632	4, 074, 247	4, 191, 740
Pennsylvania	409, 213, 802	438, 995, 247	499, 680, 694	445, 264, 824	448, 935, 291	554, 501, 375	869, 800, 965	979, 245, 098
Rhode Island	1, 253, 656	942, 842	813, 952	777, 716	855, 007	789, 206	717, 123	760, 787
South Carolina	1, 803, 579	1, 606, 989	1, 464, 150	1, 414, 294	1, 129, 709	1, 392, 073	1, 393, 297	1, 558, 543
South Dakota	8, 047, 259	8, 436, 240	7, 909, 059	7, 861, 601	8, 093, 670	8, 696, 680	8, 348, 684	7, 441, 981

[a] In this table iron ore, not pig iron, is taken as the basis of valuation of iron, and in the case of other metals mine production (recoverable content of metals) is the basis.

Value of mineral production, 1911 to 1918, by States—Continued.

State.	1911	1912	1913	1914	1915	1916	1917	1918
Tennessee	$17,899,882	$19,362,209	$21,008,938	$19,647,145	$22,166,494	$28,277,365	$36,910,448	$39,229,614
Texas	18,798,837	22,797,015	31,666,910	30,363,426	29,220,951	47,711,571	75,958,481	108,945,080
Utah	43,774,331	51,004,942	53,606,520	45,636,198	62,586,261	99,734,209	113,433,596	105,622,712
Vermont	8,434,516	9,087,560	9,647,985	8,665,867	7,586,410	8,297,104	8,980,573	9,158,945
Virginia	13,713,566	14,989,922	17,167,620	16,400,347	16,994,786	20,560,956	32,243,648	37,639,368
Washington	15,865,277	15,847,313	17,579,743	13,830,739	11,455,715	14,521,014	18,576,052	20,999,691
West Virginia	101,932,248	123,847,812	143,591,272	133,633,229	136,070,173	187,043,011	306,916,191	327,962,620
Wisconsin	11,418,958	13,826,104	11,759,590	10,414,110	18,739,343	27,082,175	24,976,780	20,091,146
Wyoming	11,483,377	13,374,088	13,682,091	12,417,752	12,708,238	19,683,292	29,547,428	42,595,812

Rank of States in value of mineral production in 1917 and 1918.

State.	Principal mineral products in 1918 (in order of value).[a]	1917		1918				
		Rank.	Value.	Rank.	Value.	Increase or decrease.	Percentage of increase or decrease.	Percentage of total for United States.
Pennsylvania	Coal, clay products, natural gas, cement	1	$869,800,965	1	$979,245,098	+$109,444,133	+12.6	22.1
Oklahoma	Petroleum, zinc, natural-gas gasoline, coal	3	259,134,377	2	336,857,921	+ 77,723,544	+30.0	7.6
West Virginia	Coal, natural gas, petroleum, clay products	2	306,916,191	3	327,962,620	+ 21,046,429	+ 6.9	7.4
Illinois	Coal, petroleum, clay products, cement	4	234,735,962	4	271,244,365	+ 36.508,403	+15.6	6.1
Ohio	Coal, clay products, natural gas, petroleum	5	217,671,746	5	246,162,215	+ 25,490,469	+18.1	5.5
California	Petroleum, gold, copper, natural gas	7	175,399,036	6	204,673,547	+ 29,274,511	+16.7	4.6
Arizona	Copper, silver, gold, lead	6	212,615,978	7	203,992,915	— 8,623,063	— 4.1	4.6
Michigan	Iron ore, copper, salt, cement	8	163,997,853	8	158,312,121	— 5,685,732	— 3.5	3.6
Minnesota	Iron ore, manganiferous ore, clay products, cement	9	152,490,554	9	155,412,823	+ 2,922,269	+ 1.9	3.5
Kansas	Petroleum, coal, natural gas, zinc	12	106,763,055	10	147,902,091	+ 41,139,036	+38.5	3.3
Montana	Copper, zinc, silver, coal	10	123,650,330	11	139,331,507	+ 15,681,177	+12.7	3.1
Texas	Petroleum, sulphur, coal, natural gas	16	75,958,481	12	108,945,080	+ 32,986,549	+43.4	2.5
Utah	Copper, coal, silver, lead	11	113,433,596	13	105,622,712	— 7,810,884	— 6.9	2.4
Kentucky	Coal, petroleum, clay products, fluorspar	17	77,174,802	14	104,165,945	+ 26,991,143	+35.0	2.3
Indiana	Coal, cement, clay products, stone	14	83,798,648	15	96,558,784	+ 12,760,136	+15.2	2.2
Colorado	Coal, gold, zinc, silver	15	80,296,218	16	79,003,928	— 1,292,290	— 1.6	1.8
Alabama	Coal, iron ore, clay products, cement	18	65,024,838	17	77,795,572	+ 12,770,734	+19.6	1.8
Missouri	Lead, coal, zinc, clay products	13	105,342,678	18	76,663,995	— 28,678,683	—27.2	1.7
Louisiana	Petroleum, sulphur, natural gas, natural-gas gasoline	26	37,521,872	19	54,769,225	+ 17,247,353	+46.0	1.2
New York	Clay products, salt, cement, iron ore	22	52,123,552	20	54,080,035	+ 1,956,483	+ 3.8	1.2

Nevada	Copper, silver, gold, lead	20	55, 408, 057	21	51, 080, 169	—	4, 327, 888	— 7.8	1.1
New Jersey	Clay products, zinc, cement, sand and gravel	19	57, 710, 181	22	49, 510, 290	—	8, 199, 891	−14.2	1.1
Wyoming	Coal, petroleum, iron ore, natural-gas gasoline	29	29, 547, 428	23	42, 595, 812	+	13, 048, 384	+44.2	1.0
New Mexico	Copper, coal, zinc, silver	23	43, 312, 947	24	40, 631, 024	—	2, 681, 923	— 6.2	.9
Tennessee	Coal, zinc, copper, clay products	27	36, 910, 448	25	39, 229, 614	+	2, 319, 166	+ 6.3	.9
Iowa	Coal, cement, clay products, gypsum	25	39, 336, 372	26	38, 742, 009	—	594, 363	— 1.5	.9
Virginia	Coal, clay products, stone, lime	28	32, 243, 648	27	37, 639, 368	+	5, 395, 720	+16.7	.8
Idaho	Lead, silver, zinc, copper	21	55, 224, 026	28	36, 872, 270	—	18, 351, 756	—33.2	.8
Alaska	Copper, gold, silver, coal	24	40, 710, 655	29	28, 217, 407	—	12, 493, 248	—30.7	.6
Washington	Coal, cement, clay products, magnesite	32	18, 576, 052	30	20, 999, 691	+	2, 423, 639	+13.0	.5
Maryland	Coal, clay products, cement, sand and gravel	31	19, 617, 596	31	20, 866, 706	+	1, 249, 110	+ 6.4	.5
Wisconsin	Zinc, iron ore, stone, mineral waters	30	24, 976, 780	32	20, 091, 146	—	4, 885, 634	—19.6	.4
Arkansas	Coal, bauxite, clay products, natural gas	33	12, 061, 702	33	14, 081, 691	+	2, 019, 989	+16.7	.3
Vermont	Stone, slate, talc and soapstone, lime	34	8, 980, 573	34	9, 158, 945	+	178, 372	+ 2.0	.2
Georgia	Clay products, stone, iron ore, cement	37	7, 650, 553	35	8, 312, 051	+	661, 498	+ 8.6	.2
Florida	Phosphate rock, fuller's earth, stone, clay products	38	7, 294, 467	36	7, 758, 732	+	464, 265	+ 6.4	.2
South Dakota	Gold, tungsten ore, silver, stone	35	8, 348, 684	37	7, 441, 981	—	906, 703	—10.9	.2
Massachusetts	Stone, clay products, sand and gravel, lime	39	7, 225, 750	38	7, 258, 088	+	32, 338	+ .4	.2
Nebraska	Potash (K_2O), clay products, stone, sand and gravel	36	7, 943, 729	39	6, 513, 422	—	1, 430, 307	—18.0	.1
North Carolina	Clay products, stone, iron ore, mica	40	5, 246, 391	40	4, 973, 386	—	273, 005	— 5.2	.1
Oregon	Gold, chromite, copper, cement	41	4, 074, 247	41	4, 191, 740	+	117, 493	+ 2.9	.1
Maine	Stone, lime, clay products, slate	43	3, 726, 121	42	3, 727, 107	+	986	+ .03	.1
Connecticut	Clay products, stone, lime, sand and gravel	42	3, 981, 203	43	3, 501, 460	—	479, 743	—12.1	.1
North Dakota	Coal, clay products, mineral waters, sand-lime brick	44	1, 749, 549	44	1, 823, 109	+	73, 560	+ 4.2	.2
South Carolina	Clay products, stone, phosphate rock, mineral waters	46	1, 393, 297	45	1, 558, 543	+	165, 246	+11.9	
New Hampshire	Stone, clay products, mica, sand and gravel	45	1, 594, 584	46	1, 453, 921	—	140, 663	— 8.8	
Mississippi	Clay products, sand and gravel, mineral waters, stone	47	966, 135	47	925, 192	—	40, 943	— 4.2	
Rhode Island	Stone, clay products, graphite, mineral waters	48	717, 123	48	760, 787	+	43, 664	+ 6.1	
Delaware	Clay products, stone, sand and gravel, mineral waters	49	523, 991	49	372, 804	—	151, 187	—28.9	
District of Columbia	Clay products, sand-lime brick, stone, mineral waters	50	204, 936	50	99, 221	—	105, 715	—51.6	

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[a] In this table iron ore, not pig iron, is taken as the basis of iron valuation, and in the case of other metals mine production (recoverable content of metals) is the basis.

Mineral production of Alabama in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Barytes ... short tons	1,976	$8,868	1,794	$9,976
Bauxite ... long tons	8,281	52,317	4,928	35,035
Cement ... barrels	1,329,833	1,494,879	1,132,963	1,719,519
Chert ... short tons	17,500	11,000	50,000	17,500
Clay products		1,759,885		2,159,104
Clay, raw ... short tons	58,667	[a] 84,763	50,048	[a] 49,193
Coal ... do	20,068,074	45,616,992	19,184,962	54,752,329
Coke ... do	4,892,589	[a] 28,394,272	4,352,172	[a] 29,062,236
Ferroalloys ... long tons	(a b)	(a b)	(a b)	(a b)
Fuller's earth ... short tons			(b)	(b)
Gold ... fine ounces (troy)	109	2,262	39	797
Graphite, crystalline ... pounds	6,223,095	719,575	7,795,475	999,152
Iron ore ... long tons	7,101,586	13,049,535	6,121,087	15,334,561
Iron, pig ... do	2,971,626	[a] 64,309,714	2,645,179	[a] 80,893,687
Lime ... short tons	66,744	383,211	49,209	439,366
Manganese ore ... long tons	264	10,538	709	(b)
Manganiferous ore ... do			443	8,424
Mica		3,808		3,150
Millstones		(b)		
Mineral waters ... gallons sold	56,270	5,509	6,315	1,808
Natural gas ... M cubic feet	(b)	(b)	4,600	1,890
Potash (K_2O) ... short tons	2	748	(b)	(b)
Pyrites ... long tons	(b)	(b)	(b)	(b)
Sand and gravel ... short tons	476,678	222,011	712,787	406,983
Sand and sandstone (finely ground) ... do	(b)	(b)		
Silica (quartz) ... do			(b)	(b)
Silver ... fine ounces (troy)	11	9	2	2
Stone		1,611,497		1,669,721
Miscellaneous [c]		4,504,428		5,845,181
Total value, eliminating duplications		65,024,838		77,795,572

[a] Value not included in total value for State.

[b] Value included under "Miscellaneous."

[c] 1917: Ferroalloys, millstones, natural gas, pyrites, and sand and sandstone (finely ground); 1918: Ferroalloys, fuller's earth, manganese ore, potash, pyrites, and silica (quartz).

Mineral production of Alaska in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Antimony ore ... short tons	84	$3,433	36	$1,500
Chromite ... long tons	(a)	(a)	(a)	(a)
Coal ... short tons	53,955	265,317	75,606	411,850
Copper ... pounds	88,793,400	24,240,598	69,224,951	17,098,563
Gold ... fine ounces (troy)	709,049	14,657,353	458,641	9,480,952
Graphite, crystalline ... pounds	(a)	(a)		
Gypsum ... short tons	(b)	(b)	(b)	(b)
Lead ... do	852	146,584	564	80,068
Petroleum ... barrels	(a)	(a)	(a)	(a)
Platinum and allied metals ... fine ounces (troy)	76	7,845	(a)	(a)
Silver ... do	1,239,150	1,021,060	847,789	847,789
Stone		(a)		(a)
Tin (metallic equivalent) ... short tons	100	123,300	68	118,000
Tungsten ore (60 per cent concentrates) ... do	32	45,000	14	22,000
Miscellaneous [c]		200,165		156,665
Total value, eliminating duplications		40,710,655		28,217,407

[a] Value included under "Miscellaneous."

[b] Calcined in Washington State. Value included under "Miscellaneous."

[c] 1917: Chromite, crystalline graphite, gypsum, petroleum, and stone; 1918: Chromite, gypsum, petroleum, platinum and allied metals, and stone.

Mineral production of Arizona in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Asbestos ....short tons..	950	$481,490	183	$95,789
Clay products........		135,474		134,562
Clay, raw........short tons..	(a b)	(a b)	(a b)	(a b)
Copper........pounds..	712,166,891	194,421,561	764,855,874	188,919,401
Flourspar........short tons..	(a)	(a)	364	5,537
Gems and precious stones........		6,819		9,206
Gold........fine ounces (troy)..	245,174	5,068,193	262,919	5,435,027
Gypsum........short tons..	(a)	(a)	(a)	(a)
Lead........do....	11,733	2,018,028	6,252	887,762
Lime........do....	15,856	119,995	11,212	126,390
Manganese ore........long tons..	14,802	479,971	17,612	570,005
Manganiferous ore........do....	34,449	200,342	12,840	91,054
Molybdenum........pounds..	344,950	487,985	154,923	219,010
Quicksilver........flasks..	40	4,213		
Sand and gravel........short tons..	17,268	5,799	3,722	5,920
Sand and sandstone (finely ground)........do....	(a)	(a)		
Silica (quartz)........do....			(a)	(a)
Silver........fine ounces (troy)..	6,983,913	5,754,744	6,686,152	6,686,152
Stone........		319,724		278,127
Sulphuric acid (60° Baumé)[c]........short tons..	(a)	(a)	(c)	(c)
Tungsten ore (60 per cent concentrates)........do....	150	173,700	213	263,100
Zinc........do....	10,447	2,131,276	1,135	206,538
Miscellaneous[d]........		806,679		59,904
Total value, eliminating duplications........		212,615,978		203,992,915

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] From copper smelting. Canvass discontinued after 1917.
[d] 1917: Raw clay, fluorspar, gypsum, sand and sandstone (finely ground), and sulphuric acid from copper smelting; 1918: Raw clay, gypsum, and silica (quartz).

Mineral production of Arkansas in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Bauxite........long tons..	506,556	$2,724,007	562,892	$3,133,880
Clay products........		[a] 672,766		[a] 679,183
Coal........short tons..	2,143,579	5,492,777	2,227,369	8,172,376
Fuller's earth........do....	(b)	(b)	(b)	(b)
Gems and precious stones........		4,260		2,010
Iron ore:				
Sold to furnaces........long tons..	40	(b)		
Sold for magnets........do....	5	(b)		
Lead........short tons..	382	65,704	120	17,040
Lime........do....	17,350	117,593	8,320	62,250
Manganese ore........long tons..	10,140	448,511	7,731	354,235
Manganiferous ore........do....	9,100	83,227	9,173	93,525
Marl, calcareous........short tons..	(b)	(b)	(b)	(b)
Mineral waters........gallons sold..	1,020,463	78,141	863,142	70,626
Natural gas........M cubic feet..	5,609,484	315,612	5,294,663	575,115
Oilstones........short tons..	(b)	(b)	325	112,031
Sand and gravel........do....	582,053	176,923	230,239	107,290
Stone........		371,732		481,998
Zinc........short tons..	6,691	1,364,964	951	173,082
Miscellaneous[c]........		145,485		47,050
Total value, eliminating duplications........		12,061,702		14,081,691

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] 1917: Pottery, fuller's earth, iron ore, calcareous marl, and oilstones; 1918: Pottery, fuller's earth, and calcareous marl.

Mineral production of California in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Antimony ore....short tons..	42	$1,594	....	....
Asbestos....do....	(a)	(a)	(a)	(a)
Asphalt....do....	226,303	2,119,699	198,535	$2,609,359
Barytes....do....	(a)	(a)	....	....
Borates....do....	108,875	3,609,632	88,794	2,263,230
Briquets, fuel....do....	(a b)	(a b)	(a b)	(a b)
Calcium chloride....do....	(a)	(a)	(a)	(a)
Cement....barrels..	5,659,547	7,426,097	4,238,424	7,091,789
Chromite....long tons..	36,774	875,248	63,147	3,078,160
Clay products....	....	4,826,125	....	4,329,220
Clay, raw....short tons..	137,892	[b] 151,348	152,311	[b] 241,420
Coal....do....	(a)	(a)	(a)	(a)
Copper....pounds..	48,153,139	13,145,807	47,674,660	11,775,641
Diatomaceous earth....short tons..	(a)	(a)	(a)	(a)
Feldspar....do....	7,874	18,543	1,451	8,839
Ferroalloys....long tons..	2,113	[b] 544,650	(a b)	(a b)
Fluorspar, optical....pounds..	....	....	(a)	(a)
Fuller's earth....short tons..	(a)	(a)	(a)	(a)
Gems and precious stones....	....	15,972	....	9,572
Gold....fine ounces (troy)..	971,733	20,087,504	799,588	16,528,953
Graphite, crystalline....pounds..	(a)	(a)	(a)	(a)
Gypsum....short tons..	30,552	96,718	(a)	(a)
Iron ore....long tons..	2,207	8,828	3,121	14,683
Lead....short tons..	10,934	1,880,702	6,686	949,415
Lime....do....	78,401	597,528	55,588	558,058
Lithium minerals....do....	(a)	(a)	(a)	(a)
Magnesite....do....	211,663	2,116,630	84,077	761,811
Manganese ore....long tons..	14,196	328,501	24,067	740,566
Manganiferous ore....do....	152	1,760	68	(a)
Marl (calcareous)....short tons..	(a)	(a)	....	....
Mineral waters....gallons sold..	2,566,491	455,360	2,399,144	433,010
Molybdenum....pounds..	(a)	(a)	....	....
Natural gas....M cubic feet..	49,427,331	6,816,524	39,718,941	7,951,666
Natural-gas gasoline....gallons..	28,817,604	4,438,022	32,268,933	5,009,152
Peat....short tons..	(a)	(a)	(a)	(a)
Pebbles for grinding....do....	9,278	48,775	3,543	26,313
Petroleum....barrels..	93,877,549	86,161,764	97,531,997	118,770,790
Platinum and allied metals....fine ounces (troy)..	297	29,014	433	47,755
Potash (K_2O)....short tons..	12,127	5,446,918	17,660	7,356,757
Pumice....do....	(a)	(a)	(a)	(a)
Pyrites....long tons..	115,817	333,501	111,861	501,541
Quicksilver....flasks..	23,938	2,521,151	22,664	2,663,020
Salt....short tons..	215,154	933,429	204,957	1,167,777
Sand and gravel....do....	3,781,388	1,138,128	3,011,842	1,070,441
Sand-lime brick....	....	(a)	....	(a)
Silica (quartz)....short tons..	7,325	18,197	3,544	4,489
Silver....fine ounces (troy)..	1,775,431	1,462,955	1,427,711	1,427,711
Slate....	....	(a)	....	(a)
Sodium salts (carbonate, bicarbonate, and sulphate) from natural sources....short tons..	20,713	891,997	19,436	974,608
Stone....	....	2,911,462	....	2,564,614
Strontium ore....short tons..	3,861	77,220	400	20,000
Sulphur acid (60° Baumé)[c]....do....	(a)	(a)	(c)	(c)
Talc and soapstone....do....	4,152	74,000	11,864	185,775
Tungsten ore (60 per cent concentrates)....do....	2,781	3,010,300	1,791	2,783,700
Zinc....do....	5,436	1,109,017	2,781	506,087
Miscellaneous[d]....	....	565,141	....	1,835,448
Total value, eliminating duplications....	....	175,399,036	....	204,673,547

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[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] From copper smelting. Canvass discontinued after 1917.

[d] 1917: Asbestos, barytes, fuel briquets, calcium chloride, coal, diatomaceous earth, fuller's earth, crystalline graphite, lithium minerals, calcareous marl, molybdenum, peat, pumice, sand-lime brick, slate, and sulphuric acid from copper smelting; 1918: Asbestos, fuel briquets, calcium chloride, coal, diatomaceous earth, ferroalloys, optical fluorspar, fuller's earth, crystalline graphite, gypsum, lithium minerals, manganiferous ore, peat, pumice, sand-lime brick, and slate.

Mineral production of Colorado in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Asphalt short tons	700	$37,500	...	...
Briquets, fuel do	(a b)	(a b)	...	...
Cement barrels	(a)	(a)	(a)	(a)
Clay products	...	2,290,854	...	$2,299,448
Clay, raw short tons	106,775	[b]103,376	98,244	[b]117,934
Coal do	12,483,336	27,669,129	12,407,571	33,404,743
Coke do	1,112,449	[b]5,479,734	989,447	[b] 7,450,136
Copper pounds	8,122,004	2,217,307	6,277,332	1,550,501
Ferroalloys long tons	30,415	[b] 1,614,701	(a b)	(a b)
Fluorspar short tons	17,104	196,633	38,475	416,780
Gems and precious stones	...	7,205	...	3,430
Gold fine ounces (troy)	760,901	15,729,224	616,864	12,751,718
Graphite, amorphous short tons	(a)	(a)	(a)	(a)
Gypsum do	(a)	(a)	(a)	(a)
Iron ore long tons	(a)	(a)	7,850	(a)
Iron, pig do	332,562	(a b)	365,395	(a b)
Lead short tons	33,995	5,847,141	32,980	4,683,214
Lime do	6,212	54,676	6,077	61,476
Manganese ore long tons	114	(a)	4,821	180,246
Manganiferous ore do	124,861	303,802	124,068	586,111
Mica	...	(a)	...	1,020
Mineral paints, zinc and lead pigments short tons	...	...	(a b)	(a b)
Mineral waters gallons sold	442,815	65,169	319,542	81,367
Molybdenum pounds	(a)	(a)	663,386	995,695
Natural gas M cubic feet	(a)	(a)	10,103	2,575
Natural-gas gasoline gallons	(a)	(a)	2,475	620
Petroleum barrels	121,231	128,100	143,286	188,472
Potash (K_2O) short tons	(a)	(a)	(a)	(a)
Pyrites long tons	20,000	(a)	18,817	115,712
Sand and gravel short tons	150,063	74,540	172,472	90,657
Silica (quartz) do	...	...	(a)	(a)
Silver fine ounces (troy)	7,304,353	6,018,787	7,063,554	7,063,554
Stone	...	823,904	...	771,472
Sulphur long tons	(a)	(a)	(a)	(a)
Sulphuric acid (60° Baumé)[c] short tons	(a)	(a)	(c)	(c)
Tungsten ore (60 per cent concentrates) do	2,707	2,994,000	1,910	2,595,800
Uranium and vanadium ores	...	587,700	...	880,328
Zinc short tons	60,158	12,272,209	44,567	8,111,185
Miscellaneous [d]	...	9,187,328	...	14,035,490
Total value, eliminating duplications	...	80,296,218	...	79,003,928

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] From zinc smelting. Canvass discontinued after 1917.

[d] 1917: Fuel briquets, cement, amorphous graphite, gypsum, iron ore, pig iron, manganese ore, mica, molybdenum, natural gas, natural-gas gasoline, potash, pyrites, sulphur, and sulphuric acid from zinc smelting; 1918: Cement, ferroalloys, amorphous graphite, gypsum, iron ore, pig iron, zinc and lead pigments, potash, silica (quartz), and sulphur.

Mineral production of Connecticut in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Clay products	...	$1,887,537	...	$1,627,508
Clay, raw short tons	(a b)	(a b)	(a b)	(a b)
Diatomaceous earth do	(a)	(a)	(a)	(a)
Feldspar do	10,937	73,932	5,942	52,117
Gems and precious stones	...	(a)	...	...
Iron ore long tons	(a)	(a)	12,130	(a)
Iron, pig do	5,343	(a b)	7,088	(a b)
Lime short tons	64,389	492,678	(a)	(a)
Mineral waters gallons sold	1,964,096	103,978	1,364,443	72,527
Peat short tons	...	...	(a)	(a)
Sand and gravel do	213,034	127,530	140,383	99,233
Silica (quartz) do	...	...	(a)	(a)
Stone	...	1,238,684	...	1,025,475
Miscellaneous [c]	...	243,997	...	1,014,546
Total value, eliminating duplications	...	3,981,203	...	3,501,460

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] 1917: Raw clay, diatomaceous earth, gems and precious stones, iron ore, and pig iron; 1918: Raw clay, diatomaceous earth, iron ore, pig iron, lime, peat, and silica (quartz).

Mineral production of Delaware in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Clay products		$197,310		$164,486
Clay, raw ... short tons	11,243	[a] 85,330	9,039	[a] 62,981
Mineral waters ... gallons sold	(b)	(b)	(b)	(b)
Sand and gravel ... short tons	166,413	101,252	103,299	76,822
Stone		216,346		(b)
Miscellaneous		9,083		131,496
Total value, eliminating duplications		523,991		372,804

[a] Value not included in total value for State.
[b] Value included under "Miscellaneous."

Mineral production of the District of Columbia in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Clay products		$160,242		$66,606
Mineral waters ... gallons sold	(a)	(a)	(a)	(a)
Sand-lime brick		(a)		(a)
Stone		4,615		7,585
Miscellaneous [b]		40,079		25,030
Total value, eliminating duplications		204,936		99,221

[a] Value included under "Miscellaneous."
[b] Mineral waters and sand-lime brick.

Mineral production of Florida in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Clay products		$229,406		[a] $181,339
Clay, raw ... short tons	(b c)	(b c)	(b c)	(b c)
Flint lining for tube mills ... do	(b)	(b)		
Fuller's earth ... do	(b)	(b)	(b)	(b)
Gems and precious stones				(b)
Ilmenite ... short tons	(b)	(b)	1,200	7,500
Lime ... do	9,914	56,903	(b)	(b)
Mineral waters ... gallons sold	142,030	9,850	164,630	12,888
Peat ... short tons	(b)	(b)	(b)	(b)
Phosphate rock ... long tons	2,022,509	5,464,493	2,067,230	6,090,106
Sand and gravel ... short tons	262,971	145,579	158,489	48,768
Sand-lime brick		95,158		(b)
Stone		654,845		304,807
Miscellaneous [d]		904,469		1,358,862
Total value, eliminating duplications		7,294,467		7,758,732

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Value not included in total value for State.
[d] 1917: Raw clay, flint lining for tube mills, fuller's earth, ilmenite, and peat; 1918: Pottery, raw clay, fuller's earth, gems and precious stones, lime, peat, and sand-lime brick.

Mineral production of Georgia in 1917 and 1918.

Product.		1917		1918	
		Quantity.	Value.	Quantity.	Value.
Asbestos	short tons	(a)	(a)	(a)	(a)
Barytes	do	111,300	$601,895	69,318	$418,178
Bauxite	long tons	52,901	337,498	35,637	265,491
Cement	barrels	(a)	(a)	(a)	(a)
Clay products			2,426,671		2,964,706
Clay, raw	short tons	187,355	[b] 599,359	140,675	[b] 641,283
Coal	do	119,028	301,391	66,716	239,377
Coke	do	39,589	[b] 322,175	22,048	[b] 193,317
Copper	pounds	930,691	254,079	397,078	98,078
Fuller's earth	short tons	(a)	(a)	(a)	(a)
Gold	fine ounces (troy)	333	6,889	285	5,893
Iron ore:					
Sold to furnaces	long tons	211,501	524,175	262,003	878,612
Sold for paint	do	(a)	(a)	3,229	(a)
Iron, pig	do	6,627	(ab)	720	(ab)
Manganese ore	do	3,614	89,888	6,679	284,615
Manganiferous ore	do	13,281	118,368	10,776	61,682
Mica			13,541		80,050
Mineral waters	gallons sold	411,127	37,441	314,388	27,810
Peat	short tons			(a)	(a)
Pyrites	long tons	23,242	155,560	31,315	268,797
Sand and gravel	short tons	380,154	138,182	270,071	121,655
Sand-lime brick			(a)		(a)
Silver	fine ounces (troy)	46	37	25	25
Stone			1,797,098		1,903,255
Talc	short tons	3,819	94,314	(a)	(a)
Miscellaneous [c]			998,526		721,827
Total value, eliminating duplications			7,650,553		8,312,051

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] 1917: Asbestos, cement, fuller's earth, iron ore sold for paint, pig iron, and sand-lime brick; 1918: Asbestos, cement, fuller's earth, iron ore sold for paint, pig iron, peat, sand-lime brick, and talc.

Mineral production of Idaho in 1917 and 1918.

Product.		1917		1918	
		Quantity.	Value.	Quantity.	Value.
Antimony ore	short tons	39	$1,715	(a)	(a)
Asbestos	do	(a)	(a)		
Clay products			(a)		(a)
Clay, raw	short tons	(a b)	(a b)	(a b)	(a b)
Coal	do	(a)	(a)	(a)	(a)
Cobalt concentrates	do			55	(a)
Copper	pounds	7,827,574	2,136,928	6,533,888	$1,613,870
Diatomaceous earth	short tons			(a)	(a)
Gems and precious stones			(a)		(a)
Gold	fine ounces (troy)	38,933	804,809	33,999	702,816
Iron ore	long tons			785	(a)
Lead	short tons	196,780	33,846,119	147,348	20,923,416
Lime	do	7,228	62,331	(a)	(a)
Mica			(a)		
Phosphate rock	long tons	(a)	(a)	(a)	(a)
Quicksilver	flasks	5	526	22	2,585
Salt	short tons	16	216	(a)	(a)
Sand and gravel	do	(a)	(a)	(a)	(a)
Sand-lime brick			(a)		(a)
Silver	fine ounces (troy)	12,029,338	9,912,175	9,172,340	9,172,340
Stone			94,644		68,367
Tungsten ore (60 per cent concentrates)	short tons	2	1,933		
Zinc	do	39,927	8,145,122	22,581	4,109,716
Miscellaneous [c]			219,248		279,685
Total value, eliminating duplications			55,224,026		36,872,270

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] 1917: Asbestos, clay products, raw clay, coal, gems and precious stones, mica, phosphate rock, sand and gravel, and sand-lime brick; 1918: Antimony ore, clay products, raw clay, coal, cobalt concentrates, diatomaceous earth, gems and precious stones, iron ore, lime, phosphate rock, salt, sand and gravel, and sand-lime brick.

Mineral production of Illinois in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Asphalt.......short tons..	110,756	$1,317,855	100,952	$1,315,001
Cement.......barrels..	[a] 4,378,233	[a] 6,090,158	[a] 3,703,471	[a] 5,695,186
Clay products.......	....	17,190,753	....	12,459,777
Clay, raw.......short tons..	195,693	[b] 789,589	169,182	[b] 413,901
Coal.......do....	86,199,387	162,281,822	89,291,105	206,860,291
Coke.......do....	2,289,833	[b] 14,455,539	2,285,610	[b] 18,625,436
Ferroalloys.......long tons..	([b] [c])	([b] [c])	([b] [c])	([b] [c])
Fluorspar.......short tons..	156,676	1,373,333	132,798	2,887,099
Iron, pig.......long tons..	3,458,126	[b] 91,094,541	3,409,876	[b] 105,415,030
Lead.......short tons..	1,439	247,508	2,273	322,766
Lime.......do....	83,409	501,320	64,672	535,090
Mineral paints, zinc and lead pigments.......do....	([b] [c])	([b] [c])	([b] [c])	([b] [c])
Mineral waters.......gallons sold..	1,370,461	66,042	921,953	43,448
Natural gas.......M cubic feet..	4,439,016	479,072	4,473,018	620,949
Natural-gas gasoline.......gallons..	4,934,009	866,033	4,574,565	890,436
Peat.......short tons..	([c])	([c])	([c])	([c])
Petroleum.......barrels..	15,776,860	31,358,069	13,365,974	31,230,000
Potash (K_2O).......short tons..	([c])	([c])	....	....
Pyrites.......long tons..	24,596	89,998	24,369	85,659
Sand and gravel.......short tons..	9,120,698	3,658,799	6,355,406	3,980,124
Sand and sandstone (finely ground).......do....	386,866	630,256	([c])	([c])
Silver.......fine ounces (troy)..	7,186	5,921	8,171	8,171
Stone.......	....	3,322,041	....	2,990,150
Sulphuric acid [d].......short tons..	....	3,902,831	([d])	([d])
Tripoli.......do....	16,133	207,738	12,004	100,126
Zinc.......do....	4,267	870,468	3,792	690,144
Miscellaneous [e].......	....	6,343,662	....	6,669,347
Total value, eliminating duplications.......	....	234,735,962	....	271,244,365

[a] Exclusive of natural cement, value for which is included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Value included under "Miscellaneous."
[d] From zinc smelting. Canvass discontinued after 1917.
[e] 1917: Natural cement, ferroalloys, zinc and lead pigments, peat, and potash; 1918: Natural cement, ferroalloys, zinc and lead pigments, peat, and sand and sandstone (finely ground).

Mineral production of Indiana in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Cement.......barrels..	[a] 8,148,678	[a] $11,084,930	[a] 6,205,326	[a] $9,580,563
Clay products.......	....	9,718,752	....	7,950,926
Clay, raw.......short tons..	73,863	[b] 78,463	104,396	[b] 131,324
Coal.......do....	26,539,329	52,940,106	30,678,634	70,384,601
Coke.......do....	3,540,718	[b] 21,831,302	3,898,215	[b] 31,462,493
Iron, pig.......long tons..	2,162,872	([b] [c])	2,583,375	[b] 75,149,991
Lime.......short tons..	118,530	646,555	116,321	865,597
Mineral waters.......gallons sold..	521,758	152,469	555,076	179,431
Natural gas.......M cubic feet..	1,711,454	453,310	1,666,822	899,671
Oilstones and scythestones.......short tons..	([d])	27,693	220	27,609
Peat.......do....	([c])	([c])	([c])	([c])
Petroleum.......barrels..	759,432	1,470,548	877,558	2,028,129
Potash (K_2O).......short tons..	....	....	([c])	([c])
Pyrites.......long tons..	([c])	([c])	....	....
Sand and gravel.......short tons..	5,906,196	1,591,158	4,785,615	1,719,417
Sand-lime brick.......	....	60,201	....	62,633
Stone.......	....	4,449,809	....	2,819,083
Sulphuric acid (60° Baumé) [e].......short tons..	([c])	([c])	([e])	([e])
Miscellaneous [f].......	....	51,582,551	....	41,124
Total value, eliminating duplications.......	....	83,798,648	....	96,558,784

[a] Exclusive of natural cement, value for which is included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Value included under "Miscellaneous."
[d] Figures of quantity not available for 1917.
[e] From zinc smelting. Canvass discontinued after 1917.
[f] 1917: Natural cement, pig iron, peat, pyrites, and sulphuric acid from zinc smelting; 1918: Natural cement, peat, and potash.

Mineral production of Iowa in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Cement...barrels	4,428,765	$6,870,863	3,188,669	$5,423,926
Clay products		7,540,213		[a] 5,313,394
Clay, raw...short tons	5,488	[b] 3,012	5,416	[b] 3,705
Coal...do	8,965,830	21,096,408	8,192,195	24,703,237
Ferroalloys...long tons	(b c)	(b c)	(b c)	(b c)
Gypsum...short tons	461,864	2,041,997	327,927	1,946,414
Iron ore...long tons	22,612	(c)		
Lead...short tons	34	5,848		
Lime...do	(c)	(c)	(c)	(c)
Mineral waters...gallons sold	99,103	12,125	87,703	3,937
Natural gas...M cubic feet	225	225	1,758	245
Sand and gravel...short tons	2,909,441	1,060,586	2,004,444	904,307
Stone		520,083		379,029
Zinc...short tons	18	3,672		
Miscellaneous [d]		539,662		1,187,938
Total value, eliminating duplications		39,336,372		38,742,009

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Value included under "Miscellaneous."
[d] 1917: Ferroalloys, iron ore, and lime; 1918: Pottery, ferroalloys, and lime.

Mineral production of Kansas in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Asphalt...short tons	(a)	(a)	(a)	(a)
Cement...barrels	[b] 3,772,884	[b] $5,271,721	[b] 2,586,834	[b] $4,219,203
Clay products		2,695,722		2,064,520
Coal...short tons	7,184,975	16,618,277	7,561,947	22,028,142
Gypsum...do	79,331	424,611	54,958	343,749
Lead...do	3,025	520,300	7,252	1,029,784
Lime...do			(a)	(a)
Mineral paints, zinc and lead pigments...do	(a c)	(a c)	(a c)	(a c)
Mineral waters...gallons sold	289,493	67,776	403,862	75,359
Natural gas...M cubic feet	24,438,848	5,701,436	27,824,641	6,640,781
Natural-gas gasoline...gallons	1,174,980	241,219	2,389,856	593,730
Petroleum...barrels	36,536,125	67,120,573	45,451,017	100,546,202
Pumice...short tons	(a)	(a)	(a)	(a)
Salt...do	746,976	2,027,466	819,504	3,598,289
Sand and gravel...do	823,403	195,578	761,110	264,073
Stone		673,831		561,382
Sulphuric acid (60° Baumé) [d]...short tons	(a)	(a)	(d)	(d)
Zinc...do	20,249	4,130,796	30,197	5,495,854
Miscellaneous [e]		2,285,603		1,714,262
Total value, eliminating duplications		106,763,055		147,902,091

[a] Value included under "Miscellaneous."
[b] Exclusive of natural cement, value for which is included under "Miscellaneous."
[c] Value not included in total value for State.
[d] From zinc smelting. Canvass discontinued after 1917.
[e] 1917: Asphalt, natural cement, zinc and lead pigments, pumice, and sulphuric acid from zinc smelting; 1918: Asphalt, natural cement, lime, zinc and lead pigments, and pumice.

Mineral production of Kentucky in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	(a)	(a)	(a)	(a)
Barytes.....do....	6,720	$36,084	(a)	(a)
Cement.....barrels..	(a)	(a)	(a)	(a)
Clay products.....	.....	5,037,636	.....	$6,172,554
Clay, raw.....short tons..	91,727	[b] 320,365	91,367	[b] 327,317
Coal.....do....	27,807,971	60,297,653	31,612,617	80,666,842
Coke.....do....	863,071	[b] 4,119,263	818,785	[b] 4,455,995
Ferroalloys.....long tons..	(a b)	(a b)	.....	.....
Fluorspar.....short tons..	43,639	697,566	[c] 87,604	[c] 2,069,185
Iron, pig.....long tons..	192,204	[b] 5,532,367	234,952	[b] 8,031,994
Lead.....short tons..	123	21,156	185	26,270
Lime.....do....	723	3,783	1,884	14,925
Lithographic stone.....do....	3	489	3	350
Mineral waters.....gallons sold..	301,748	40,189	255,852	41,997
Natural gas.....M cubic feet..	2,802,079	580,380	3,022,439	665,843
Natural-gas gasoline.....gallons..	3,818,209	763,186	3,330,986	660,108
Oilstones.....short tons..	(a)	(a)	(a)	(a)
Petroleum.....barrels..	3,088,160	7,033,714	4,367,968	11,287,162
Phosphate rock.....long tons..	(a)	(a)	(a)	(a)
Pyrites.....do....	(a)	(a)	(a)	(a)
Sand and gravel.....short tons..	905,414	490,546	818,471	557,548
Sand-lime brick.....	.....	(a)	.....	.....
Stone.....	.....	1,118,434	.....	970,494
Zinc.....short tons..	751	153,204	315	57,330
Miscellaneous [d].....	.....	1,698,558	.....	975,337
Total value, eliminating duplications.....	.....	77,174,802	.....	104,165,945

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Exclusive of optical fluorspar, value for which is included under "Miscellaneous."
[d] 1917: Asphalt, cement, ferroalloys, oilstones, phosphate rock, pyrites, and sand-lime brick; 1918: Asphalt, barytes, cement, optical fluorspar, oilstones, phosphate rock, and pyrites.

Mineral production of Louisiana in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	(a)	(a)	(a)	(a)
Clay products.....	.....	$447,941	.....	$458,445
Mineral waters.....gallons sold..	270,000	19,490	(a)	(a)
Natural gas.....M cubic feet..	31,286,476	3,262,987	36,094,132	4,912,235
Natural-gas gasoline.....gallons..	4,979,754	814,747	7,020,538	1,178,651
Petroleum.....barrels..	11,392,201	17,224,602	16,042,600	27,535,060
Potash (K_2O).....short tons..	(a)	(a)	487	188,439
Salt.....do....	(a)	(a)	(a)	(a)
Sand and gravel.....do....	1,514,522	639,807	1,024,498	595,682
Sand-lime brick.....	.....	(a)	.....	(a)
Stone.....	.....	(a)	.....	(a)
Sulphur.....long tons..	(a)	(a)	(a)	(a)
Miscellaneous [b].....	.....	15,112,298	.....	19,900,713
Total value, eliminating duplications.....	.....	37,521,872	.....	54,769,225

[a] Value included under "Miscellaneous."
[b] 1917: Asphalt, potash, salt, sand-lime brick, stone, and sulphur; 1918: Asphalt mineral waters, salt, sand-lime brick, stone, and sulphur.

Mineral production of Maine in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Clay products		[a] $531,870		$500,725
Copper ... pounds	30,406	8,301	766,000	189,202
Feldspar ... short tons	35,527	291,252	25,376	283,957
Gems and precious stones		10,870		7,132
Gold ... fine ounces (troy)			33	682
Lime ... short tons	124,199	950,811	83,034	906,179
Magnesium ... pounds	(b c)	(b c)	(b c)	(b c)
Mineral waters ... gallons sold	1,014,084	343,587	829,338	266,168
Peat ... short tons			(b)	(b)
Potash (K_2O) ... do			(b)	(b)
Sand and gravel ... do	8,169	7,358	35,623	31,421
Silica (quartz) ... do	(b)	(b)	(b)	(b)
Silver ... fine ounces (troy)			6,338	6,338
Slate		(b)		(b)
Stone		1,254,637		1,212,643
Miscellaneous [d]		389,061		659,964
Total value, eliminating duplications		3,726,121		3,727,107

[a] Exclusive of pottery, value for which is included under "Miscellaneous."

[b] Value included under "Miscellaneous."

[c] Value not included in total value for State.

[d] 1917: Pottery, magnesium, silica (quartz), and slate; 1918: Magnesium, peat, potash, silica (quartz), and slate.

Mineral production of Maryland in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Asbestos ... short tons	(a)	(a)	(a)	(a)
Cement ... barrels	(a)	(a)	(a)	(a)
Chromite ... long tons	(a)	(a)	(a)	(a)
Clay products		$2,468,138		$2,721,115
Clay, raw ... short tons	42,364	[b] 114,027	23,254	[b] 65,387
Coal ... do	4,745,924	11,667,852	4,497,297	12,466,189
Coke ... do	518,810	[b] 3,925,418	474,368	(a b)
Copper ... pounds	291,501	79,580		
Diatomaceous earth ... short tons	(a)	(a)		
Feldspar ... do	15,779	56,958	8,784	40,299
Ferroalloys ... long tons	33,097	[b] 4,448,031	(a b)	(a b)
Gold ... fine ounces (troy)	3	66		
Iron ore ... long tons	10,730	40,423	6,070	23,686
Iron, pig ... do	393,813	(a b)	370,993	(a b)
Lime ... short tons	133,087	694,576	106,737	808,766
Millstones				(a)
Mineral paints, zinc and lead pigments ... short tons			(a b)	(a b)
Mineral waters ... gallons sold	1,036,045	86,938	1,089,966	100,575
Natural gas ... M cubic feet			(a)	(a)
Potash (K_2O) ... short tons	792	341,885	(a)	(a)
Sand and gravel ... do	1,727,440	923,463	1,759,419	1,303,780
Silica (quartz) ... do	3,251	22,633	9,015	47,796
Silver ... fine ounces (troy)	1,092	900		
Slate		67,938		42,113
Stone		938,637		921,199
Talc ... short tons	(a)	(a)	(a)	(a)
Miscellaneous [c]		11,740,502		20,619,278
Total value, eliminating duplications		19,617,596		20,866,706

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] 1917: Asbestos, cement, chromite, diatomaceous earth, pig iron, and talc; 1918: Asbestos, cement, chromite, coke, ferroalloys, pig iron, millstones, zinc and lead pigments, natural gas, potash, and talc.

Mineral production of Massachusetts in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Clay products		$1,971,980		$1,493,765
Clay, raw ... short tons	847	[a] 1,329	2,176	[a] 6,373
Coke ... do	595,113	(a b)	556,397	(a b)
Fuller's earth ... do	(b)	(b)	(b)	(b)
Gems and precious stones		(b)		
Iron ore ... long tons	10,019	(b)	10,228	(b)
Iron, pig ... do	5,061	(a b)	4,467	(a b)
Lime ... short tons	134,937	916,569	123,697	1,030,929
Mineral waters ... gallons sold	2,908,638	139,075	1,999,592	125,208
Peat ... short tons	(b)	(b)	18,500	160,200
Potash (K_2O) ... do	(b)	(b)	(b)	(b)
Sand and gravel ... do	1,005,952	694,960	1,170,562	1,133,884
Sand-lime brick		127,695		55,440
Silica (quartz) ... short tons	(b)	(b)	4,506	15,104
Stone		3,113,423		3,069,461
Talc ... short tons	(b)	(b)	(b)	(b)
Miscellaneous [c]		4,279,961		6,169,606
Total value, eliminating duplications		7,225,750		7,258,088

[a] Value not included in total value for State.
[b] Value included under "Miscellaneous."
[c] 1917: Coke, fuller's earth, gems and precious stones, iron ore, pig iron, peat, potash, silica (quartz), and talc; 1918: Coke, fuller's earth, iron ore, pig iron, potash, and talc.

Mineral production of Michigan in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Bromine ... pounds	735,654	$405,059	1,605,696	$855,841
Calcium chloride ... short tons	22,679	294,693	20,615	394,200
Cement ... barrels	4,313,771	6,122,887	3,618,088	6,078,167
Clay products		4,034,245		3,685,172
Clay, raw ... short tons	5,746	[a] 13,627	2,359	[a] 6,373
Coal ... do	1,374,805	4,426,314	1,464,818	5,615,097
Coke ... do	(a b)	(a b)	(a b)	(a b)
Copper ... pounds	255,710,128	69,808,865	226,794,139	56,018,152
Gems and precious stones		95		364
Graphite, amorphous ... short tons	(b)	(b)		
Grindstones ... do	(b)	(b)	(b)	(b)
Gypsum ... do	375,803	1,568,655	286,768	1,761,149
Iron ore:				
Sold to furnaces ... long tons	17,712,916	62,833,624	17,587,416	65,900,501
Sold for paint ... do	1,445	(b)	101	(b)
Iron, pig ... do	611,446	[a] 18,300,501	502,884	[a] 17,823,684
Lime ... short tons	135,920	892,682	134,813	1,186,007
Magnesium ... pounds	(b)	(b)	(b)	(b)
Manganiferous ore ... long tons	52,198	(b)	22,673	(b)
Mineral waters ... gallons sold	1,069,164	105,641	1,216,882	129,592
Natural gas ... M cubic feet	1,184	1,013	1,173	1,045
Petroleum ... barrels	(b)	(b)	(b)	(b)
Potash (K_2O) ... short tons	381	299,395	369	188,390
Salt ... do	2,250,930	6,877,202	2,403,125	9,048,650
Sand and gravel ... do	3,814,445	1,641,748	2,837,371	1,239,874
Sand-lime brick		370,723		198,633
Scythestones ... short tons	(b)	(b)	(b)	(b)
Silica (quartz) ... do	(b)	(b)	(b)	(b)
Silver ... fine ounces (troy)	688,551	567,366	509,467	509,467
Stone		3,423,825		5,264,432
Miscellaneous [c]		5,791,496		8,492,319
Total value, eliminating duplications		163,997,853		158,312,121

[a] Value not included in total value for State.
[b] Value included under "Miscellaneous."
[c] 1917: Coke, amorphous graphite, grindstones, iron ore sold for paint, magnesium, manganiferous ore, petroleum, scythestones, and silica (quartz); 1918: Coke, grindstones, iron ore sold for paint, magnesium, manganiferous ore, petroleum, scythestones, and silica (quartz).

Mineral production of Minnesota in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Cement....barrels..	1,552,250	$2,143,671	1,181,529	$1,789,561
Clay products....	....	[a] 2,197,664	....	[a] 1,503,659
Clay, raw....short tons..	(b c)	(b c)	(b c)	(b c)
Coke....do....	490,272	[c] 3,468,355	784,065	[c] 6,806,468
Flint lining for tube mills....do....	(b)	(b)	1,200	21,600
Gems and precious stones....	....	(b)	....	(b)
Iron ore....long tons..	44,962,127	142,901,148	43,263,240	144,706,532
Iron, pig....do....	363,180	(b c)	386,775	(b c)
Lime....short tons..	18,072	119,704	10,792	86,882
Manganiferous ore....long tons..	451,163	2,055,335	860,696	4,242,857
Mineral waters....gallons sold..	3,004,546	109,964	2,248,731	99,159
Pebbles for grinding....short tons..	(b)	(b)	(b)	(b)
Sand and gravel....do....	1,209,455	488,069	1,150,660	492,232
Sand-lime brick....	....	152,531	....	90,212
Stone....	....	1,711,318	....	1,710,267
Miscellaneous [d]....	....	9,993,125	....	11,968,964
Total value, eliminating duplications....	....	152,490,554	....	155,412,823

[a] Exclusive of pottery, value for which is included under "Miscellaneous."

[b] Value included under "Miscellaneous."

[c] Value not included in total value for State.

[d] 1917: Pottery, raw clay, flint lining for tube mills, gems and precious stones, pig iron, and pebbles for grinding; 1918: Pottery, raw clay, gems and precious stones, pig iron, and pebbles for grinding.

Mineral production of Mississippi in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Clay products....	....	$553,585	....	$528,481
Clay, raw....short tons..	(a b)	(a b)	4,066	[b] 28,027
Mineral waters....gallons sold..	197,555	49,786	175,533	47,539
Sand and gravel....short tons..	1,414,048	360,664	1,199,515	346,653
Stone....	....	(a)	....	(a)
Miscellaneous....	....	51,000	....	2,519
Total value, eliminating duplications....	....	966,135	....	925,192

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

Mineral production of Missouri in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Barytes....short tons..	59,046	$391,363	49,094	$393,738
Briquets, fuel....do..	(a b)	(a b)	(a b)	(a b)
Cement....barrels..	5,800,988	8,248,007	4,515,695	7,132,470
Chats....short tons..	1,426,716	285,343	902,129	270,000
Clay products....	....	10,291,977	....	9,155,088
Clay, raw....short tons..	497,267	[b] 1,386,338	464,446	[b] 1,192,996
Coal....do....	5,670,549	13,755,864	5,667,730	17,126,498
Cobalt....do....	....	....	(c)	(c)
Coke....do....	(a b)	(a b)	(a b)	(a b)
Copper....pounds..	365,013	99,649	577,665	142,683
Iron ore....long tons..	38,770	134,906	71,968	270,337
Iron, pig....do....	(a b)	(a b)	83,432	[b] 3,084,136
Lead....short tons..	234,156	40,274,832	194,175	27,572,850
Lime....do....	234,936	1,435,914	201,737	1,721,800
Mineral paints, zinc and lead pigments....do....	(a b)	(a b)	(a b)	(a b)
Mineral waters....gallons sold..	401,776	57,175	306,299	38,478
Natural gas....M cubic feet..	31,425	8,230	22,120	5,548
Potash (K_2O)....short tons..	....	....	(a)	(a)
Pyrites....long tons..	(a)	(a)	7,674	69,202
Sand and gravel....short tons..	2,274,072	1,101,745	1,743,616	772,753
Silver....fine ounces (troy)..	61,586	50,747	46,939	46,939
Stone....	....	1,983,300	....	1,668,789
Tripoli....short tons..	[d] 8,303	[d] 85,978	[d] 6,778	[d] 81,728
Zinc....do....	132,918	27,115,272	55,992	10,190,544
Miscellaneous [e]....	....	5,630,279	....	3,355,173
Total value, eliminating duplications....	....	105,342,678	....	76,663,995

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] Small production. Figures not available.

[d] Includes small production from Oklahoma. Not separable.

[e] 1917: Fuel briquets, coke, pig iron, zinc and lead pigments, and pyrites; 1918: Fuel briquets, coke, zinc and lead pigments, and potash.

Mineral production of Montana in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Cement........barrels..	([a])	([a])	([a])	([a])
Clay products........		$580,730		$464,715
Clay, raw........short tons..	7,083	[b] 26,710	9,418	[b] 24,503
Coal........do....	4,226,689	8,919,136	4,532,505	11,444,875
Copper........pounds..	274,462,574	74,928,283	323,174,850	79,824,188
Ferroalloys........long tons..			([a] [b])	([a] [b])
Gems and precious stones........		59,130		47,753
Gold........fine ounces (troy)..	170,147	3,517,253	150,193	3,104,764
Graphite, crystalline........pounds..	([a])	([a])	([a])	([a])
Gypsum........short tons..	([a])	([a])	([a])	([a])
Iron ore........long tons..	([a])	([a])	1,415	([a])
Lead........short tons..	10,976	1,887,805	18,568	2,636,647
Lime........do....	5,281	35,512	([a])	([a])
Manganese ore........long tons..	61,109	1,797,842	199,932	4,623,378
Manganiferous ore........do....	1,568	([a])		
Mineral waters........gallons sold..	211,133	9,570	193,557	8,912
Natural gas........M cubic feet..	334,421	81,406	177,039	62,148
Petroleum........barrels..	99,399	146,272	69,323	125,828
Potash (K_2O)........short tons..			([a])	([a])
Sand and gravel........do....	597,642	139,384	348,347	74,474
Silver........fine ounces (troy)..	13,128,142	10,817,589	16,797,479	16,797,479
Stone........		255,835		282,228
Sulphuric acid (60° Baumé) [c]........short tons..	([a])	([a])	([c])	([c])
Tungsten ore (60 per cent concentrates)........do....	16	21,500	22	31,800
Zinc........do....	93,130	18,998,452	104,629	19,042,491
Miscellaneous [d]........		1,454,631		787,627
Total value, eliminating duplications........		123,650,330		139,331,507

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] From copper smelting. Canvass discontinued after 1917.

[d] 1917: Cement, crystalline graphite, gypsum, iron ore, manganiferous ore, and sulphuric acid from copper smelting; 1918: Cement, ferroalloys, crystalline graphite, gypsum, iron ore, lime, and potash.

Mineral production of Nebraska in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Cement........barrels..	([a])	([a])		
Clay products........		[b] $1,160,508		[b] $789,612
Clay, raw........short tons..	1,980	[c] 4,412	1,351	[c] 2,463
Gems and precious stones........				([a])
Mineral paints, zinc and lead pigments..short tons..			([a] [c])	([a] [c])
Mineral waters........gallons sold..	([a])	([a])	1,080	155
Potash (K_2O)........short tons..	14,558	5,879,534	14,011	5,098,023
Pumice........do....	5,051	16,707	([a])	([a])
Sand and gravel........do....	1,327,152	358,414	975,318	278,638
Sodium carbonate from natural sources........do....			([a])	([a])
Stone........		476,307		315,200
Miscellaneous [d]........		52,259		77,576
Total value, eliminating duplications........		7,943,729		6,513,422

[a] Value included under "Miscellaneous."

[b] Exclusive of pottery, value for which is included under "Miscellaneous."

[c] Value not included in total value for State.

[d] 1917: Cement, pottery, and mineral waters; 1918: Pottery, gems and precious stones, zinc and lead pigments, pumice, and sodium carbonate from natural sources.

Mineral production of Nevada in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Antimony ore...short tons..	872	$46,609	95	(a)
Barytes...do....	(a)	(a)	(a)	(a)
Clay products...		(a)		(a)
Clay, raw...short tons..	(a b)	(a b)	180	[b] $1,805
Copper...pounds..	122,794,704	33,522,954	116,316,441	28,730,161
Diatomaceous earth...short tons..	(a)	(a)	(a)	(a)
Fuller's earth...do....			(a)	(a)
Gems and precious stones...		17,851		21,674
Gold...fine ounces (troy)..	336,664	6,959,468	320,239	6,619,937
Graphite, amorphous...short tons..	(a)	(a)	(a)	(a)
Gypsum...do....	(a)	(a)	(a)	(a)
Iron ore...long tons..	1,010	(a)	20,303	(a)
Lead...short tons..	13,839	2,380,302	11,658	1,655,474
Lime...do....	(a)	(a)	(a)	(a)
Manganese ore...long tons..	3,450	91,907	19,872	544,727
Manganiferous ore...do....	122,872	142,543	80,354	112,014
Mineral waters...gallons sold..	(a)	(a)	(a)	(a)
Molybdenum...pounds..	(a)	(a)		
Pebbles for grinding...short tons..	(a)	(a)	(a)	(a)
Platinum and allied metals...fine ounces (troy)..	507	55,021	(a)	(a)
Potash (K_2O)...short tons..			(a)	(a)
Quicksilver...flasks..	997	105,004	1,044	122,670
Salt...short tons..	(a)	(a)	970	4,175
Sand and gravel...do....	75,466	8,813	25,325	3,943
Silver...fine ounces (troy)..	11,269,969	9,286,454	10,000,599	10,000,599
Stone...		31,625		95,821
Sulphur...long tons..	(a)	(a)	(a)	(a)
Tungsten ore (60 per cent concentrates)..short tons..	143	187,500	898	1,091,900
Uranium and vanadium ores...				3,448
Zinc...short tons..	11,154	2,275,402	8,362	1,521,953
Miscellaneous [c]...		297,624		551,673
Total value, eliminating duplications...		55,408,057		51,080,169

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[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] 1917: Barytes, clay products, raw clay, diatomaceous earth, amorphous graphite, gypsum, iron ore, lime, mineral waters, molybdenum, pebbles for grinding, salt, and sulphur; 1918: Antimony ore, barytes, clay products, diatomaceous earth, fuller's earth, amorphous graphite, gypsum, iron ore, lime, mineral waters, pebbles for grinding, platinum and allied metals, potash, and sulphur.

Mineral production of New Hampshire in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Clay products...		[a] $411,876		[a] $235,219
Feldspar...short tons..	(b)	(b)		
Fluorspar...do....	(b)	(b)	(b)	(b)
Garnet, abrasive...do....	(b)	(b)	(b)	(b)
Gems and precious stones...		(b)		(b)
Lead...short tons..	48	8,256	30	4,260
Mica...		169,051		113,240
Mineral waters...gallons sold..	105,181	6,975	182,326	8,256
Peat...short tons..			(b)	(b)
Sand and gravel...do....	258,638	28,070	123,743	17,003
Scythestones...do....	(b)	(b)	(b)	(b)
Silver...fine ounces (troy)..	120	99	1,200	1,200
Stone...		921,943		1,013,526
Zinc...short tons..	45	9,190	14	2,548
Miscellaneous [c]...		39,124		58,669
Total value, eliminating duplications...		1,594,584		1,453,921

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[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] 1917: Pottery, feldspar, fluorspar, abrasive garnet, gems and precious stones, and scythestones· 1918: Pottery, fluorspar, abrasive garnet, gems and precious stones, peat, and scythestones.

Mineral production of New Jersey in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Briquets, fuel..........short tons..	....	....	(a b)	(a b)
Cement..........barrels..	2,397,069	$2,962,592	(a)	(a)
Clay products..........	....	22,529,232	....	$20,741,244
Clay, raw..........short tons..	380,362	b 1,035,703	286,474	b 1,068,572
Coke..........do....	423,361	(a b)	682,148	(a b)
Ferroalloys..........long tons..	6,228	(a b)	(a b)	(a b)
Gems and precious stones..........	....	(a)	....	(a)
Iron ore..........long tons..	474,708	2,341,160	375,238	1,945,651
Iron, pig..........do....	187,753	b 6,618,536	222,418	b 7,611,885
Lime..........short tons..	5,002	18,978	2,208	12,268
Manganese ore..........long tons..	....	....	64	(a)
Manganiferous residuum c..........do....	155,332	(a)	146,796	(a)
Marl, greensand..........short tons..	408	384	3,582	4,775
Mineral paints, zinc and lead pigments..........do....	(a b)	(a b)	(a b)	(a b)
Mineral waters..........gallons sold..	1,283,157	115,188	1,134,848	110,150
Peat..........short tons..	42,361	320,550	26,218	264,822
Sand and gravel..........do....	3,782,457	2,025,324	3,579,862	2,462,864
Sand and sandstone (finely ground)..........do....	(a)	(a)	(a)	(a)
Slate..........	....	(a)	....	(a)
Stone..........	....	1,860,397	....	2,210,407
Sulphuric acid (60° Baumé)d..........short tons..	(a)	(a)	(d)	(d)
Talc..........do....	(a)	(a)	(a)	(a)
Zinc..........do....	120,846	(a)	98,470	(a)
Miscellaneous e..........	....	30,021,763	....	29,186,069
Total value, eliminating duplications..........	....	57,710,181	....	49,510,290

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Ore mined in New Jersey; smelted in Pennsylvania.
[d] From copper smelting. Canvass discontinued after 1917.
[e] 1917: Coke, ferroalloys, gems and precious stones, manganiferous residuum, zinc and lead pigments, sand and sandstone (finely ground); slate, sulphuric acid from copper smelting, talc, and zinc; 1918: Fuel briquets, cement, coke, ferroalloys, gems and precious stones, manganese ore, manganiferous residuum, zinc and lead pigments, sand and sandstone (finely ground), slate, talc, and zinc.

Mineral production of New Mexico in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Barytes..........short tons..	....	....	(a)	(a)
Clay products..........	....	$257,875	....	$194,533
Clay, raw..........short tons..	2,269	b 8,931	4,213	b 13,488
Coal..........do....	4,000,527	7,455,166	4,023,239	10,787,082
Coke..........do....	577,679	b 2,805,277	597,072	b 3,729,312
Copper..........pounds..	105,568,000	28,820,064	98,264,563	24,271,347
Fluorspar..........short tons..	....	....	3,437	64,348
Gems and precious stones..........	....	(a)	....	1,079
Gold..........fine ounces (troy)..	51,479	1,064,158	33,030	682,791
Gypsum..........short tons..	(a)	(a)	(a)	(a)
Iron ore..........long tons..	231,604	381,275	275,266	546,212
Lead..........short tons..	4,554	783,357	4,199	596,275
Lime..........do....	1,829	12,327	(a)	(a)
Manganese ore..........long tons..	2,603	54,143	3,126	80,195
Manganiferous ore..........do....	15,900	(a)	33,307	159,890
Mica..........	....	....	....	(a)
Mineral paints, zinc and lead pigments..short tons..	(a b)	(a b)	(a b)	(a b)
Mineral waters..........gallons sold..	48,325	2,330	(a)	(a)
Molybdenum..........pounds..	....	....	43,328	38,995
Salt..........short tons..	(a)	(a)	(a)	(a)
Sand and gravel..........do....	(a)	(a)	(a)	(a)
Silver..........fine ounces (troy)..	1,394,365	1,148,957	782,421	782,421
Stone..........	....	72,411	....	86,343
Tungsten ore (60 per cent concentrates)..short tons..	(a)	(a)	4	4,800
Zinc..........do....	15,100	3,080,400	12,025	2,188,579
Miscellaneous c..........	....	188,984	....	274,234
Total value, eliminating duplications..........	....	43,312,947	....	40,631,024

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] 1917: Gems and precious stones, gypsum, manganiferous ore, zinc and lead pigments, salt, sand and gravel, and tungsten ore; 1918: Barytes, gypsum, lime, mica, zinc and lead pigments, mineral waters, salt, and sand and gravel.

Mineral production of New York in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Aluminum..........pounds..	([a] [b])	([a] [b])	([a] [b])	([a] [b])
Cement..........barrels..	5,466,355	$7,092,051	[c] 4,074,159	[c] $6,568,746
Clay products..........	....	11,428,399	....	10,892,954
Clay, raw..........short tons..	11,894	[b] 51,505	10,120	[b] 41,541
Coke..........do....	993,184	[b] 6,889,424	1,069,587	[b] 9,920,419
Diatomaceous earth..........do....	([a])	([a])	([a])	([a])
Emery..........do....	15,941	170,223	8,183	61,660
Feldspar..........do....	13,462	62,003	12,631	71,590
Ferroalloys..........long tons..	12,677	[b] 3,289,472	45,961	[b] 8,289,765
Garnet, abrasive..........short tons..	4,786	193,440	4,126	232,661
Gems and precious stones..........	....	....	....	([a])
Graphite:				
Artificial..........pounds..	10,474,649	([a] [b])	9,182,272	([a] [b])
Crystalline..........do....	2,941,040	261,548	3,266,518	273,188
Gypsum..........short tons..	606,268	2,293,418	531,038	2,670,099
Iron ore:				
Sold to furnaces..........long tons..	1,356,011	7,381,333	899,970	5,802,870
Sold for paint..........do....	11,212	([a])	3,032	([a])
Iron, pig..........do....	2,276,367	[b] 52,318,661	2,482,450	[b] 70,167,542
Lead..........short tons..	....	....	29	4,161
Lime..........do....	108,788	892,855	87,127	913,366
Magnesium..........pounds..	83,000	[b] 168,000	([a] [b])	([a] [b])
Marl, calcareous..........short tons..	([a])	([a])	([a])	([a])
Millstones..........	....	22,103	....	25,488
Mineral waters..........gallons sold..	7,819,314	562,874	5,887,746	566,910
Natural gas..........M cubic feet..	8,371,747	2,499,303	8,460,583	5,673,131
Natural-gas gasoline..........gallons..	154,882	28,377	218,131	55,405
Peat..........short tons..	2,619	6,027	3,251	46,030
Petroleum..........barrels..	879,685	2,850,378	808,843	3,307,814
Potash (K^{2}O)..........short tons..	5	2,086	([a])	([a])
Pyrites..........long tons..	([a])	([a])	63,982	422,958
Salt..........short tons..	2,164,069	5,371,713	2,130,580	7,336,867
Sand and gravel..........do....	7,119,013	3,046,447	4,172,733	2,176,472
Sand-lime brick..........	....	130,626	....	79,515
Silica (quartz)..........short tons..	([a])	([a])	([a])	([a])
Silver..........fine ounces (troy)..	....	....	129	129
Slate..........	....	55,207	....	11,383
Slate granules..........short tons..	....		([d])	([d])
Stone..........	....	5,399,403	....	5,208,752
Talc, fibrous..........short tons..	74,671	881,462	71,167	902,100
Zinc..........do....	5,192	1,059,186	3,776	687,230
Miscellaneous [e]..........	....	33,782,370	....	29,125,814
Total value, eliminating duplications..........	....	52,123,552	....	54,080,035

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] Exclusive of natural cement, value for which is included under "Miscellaneous."

[d] Included in figures for Vermont. Not separable.

[e] 1917: Aluminum, diatomaceous earth, artificial graphite, iron ore sold for paint, calcareous marl, pyrites, and silica (quartz); 1918: Aluminum, natural cement, diatomaceous earth, gems and precious stones, artificial graphite, iron ore sold for paint, magnesium, calcareous marl, potash, and silica (quartz).

Mineral production of North Carolina in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Aluminum ... pounds	(a b)	(a b)	(a b)	(a b)
Asbestos ... short tons	....	....	(a)	(a)
Barytes ... do	1,019	$5,080	(a)	(a)
Chromite ... long tons	(a)	(a)	124	(a)
Clay products	....	1,662,307	....	$1,589,508
Clay, raw ... short tons	17,426	[b] 182,176	16,054	[b] 222,205
Coal ... do	....	....	1,420	6,745
Copper ... pounds	124,991	34,123	....	....
Corundum ... short tons	820	67,461	(a)	(a)
Emery ... do	....	....	300	2,100
Feldspar ... do	47,559	131,442	40,020	160,275
Garnet, abrasive ... do	(a)	(a)	(a)	(a)
Gems and precious stones	....	(a)	....	255
Gold ... fine ounces (troy)	590	12,187	79	1,631
Iron ore ... long tons	90,957	445,898	108,332	604,592
Lead ... short tons	1	222	....	....
Lime ... do	(a)	(a)	(a)	(a)
Manganese ore ... long tons	102	(a)	315	(a)
Manganiferous ore ... do	....	....	30	(a)
Marl, calcareous ... short tons	11,728	29,261	29,634	86,585
Mica	....	577,341	....	473,380
Millstones	....	(a)	....	39,224
Mineral waters ... gallons sold	103,659	15,664	65,422	8,174
Monazite sand ... pounds	22,000	1,760	....	....
Peat ... short tons	....	....	(a)	(a)
Sand and gravel ... do	543,364	231,813	458,578	209,553
Silica (quartz) ... do	(a)	(a)	3,497	9,352
Silver ... fine ounces (troy)	1,110	915	17	17
Stone	....	1,896,554	....	1,581,381
Talc ... short tons	2,175	41,766	1,661	72,348
Miscellaneous [c]	....	4,221,977	....	7,125,334
Total value, eliminating duplications	....	5,246,391	....	4,973,386

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] 1917: Aluminum, chromite, abrasive garnet, gems and precious stones, lime, manganese ore, millstones, and silica (quartz); 1918: Aluminum, asbestos, barytes, chromite, corundum, abrasive garnet, lime, manganese and manganiferous ores, and peat.

Mineral production of North Dakota in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Briquets, fuel ... short tons	(a b)	(a b)	....	....
Clay products	....	$294,016	....	$176,843
Clay, raw ... short tons	(a b)	(a b)	(a b)	(a b)
Coal ... do	790,548	1,425,750	719,733	1,629,668
Gems and precious stones	....	....	....	(a)
Mineral waters ... gallons sold	556,000	12,837	530,000	13,700
Natural gas ... M cubic feet	(a)	(a)	913	475
Sand and gravel ... short tons	5,750	4,425	(a)	(a)
Sand-lime brick	....	(a)	....	(a)
Miscellaneous [c]	....	22,527	....	2,976
Total value, eliminating duplications	....	1,749,549	....	1,823,109

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] 1917: Fuel briquets, raw clay, natural gas, and sand-lime brick; 1918: Raw clay, gems and precious stones, sand and gravel, and sand-lime brick.

Mineral production of Ohio in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	....	....	(a)	(a)
Bromine.....pounds..	(a)	(a)	(a)	(a)
Calcium chloride.....short tons..	(a)	(a)	(a)	(a)
Cement.....barrels..	1,565,394	$2,328,432	[b] 1,289,887	[b] $2,208,119
Clay products.....	....	51,957,043	....	52,899,180
Clay, raw.....short tons..	396,796	[c] 568,687	405,353	[c] 744,215
Coal.....do....	40,748,734	100,897,148	45,812,943	118,095,518
Coke.....do....	3,694,302	[c] 23,473,764	5,365,243	[c] 36,691,406
Ferroalloys.....long tons..	79,951	[c] 3,754,745	79,932	[c] 3,708,552
Grindstones and pulpstones.....short tons..	(d)	894,380	53,198	1,356,264
Gypsum.....do....	270,538	1,304,497	199,456	1,239,649
Iron, pig.....long tons..	8,469,052	[c] 231,165,093	8,711,205	[c] 263,189,621
Lime.....short tons..	479,856	2,975,466	489,893	4,640,536
Mineral waters.....gallons sold..	3,113,093	136,710	2,771,485	150,711
Natural gas.....M cubic feet..	68,917,231	18,434,814	61,261,069	24,234,741
Natural-gas gasoline.....gallons..	5,439,560	1,051,376	6,744,907	1,355,447
Oilstones and scythestones.....short tons..	(d)	16,957	200	20,023
Petroleum.....barrels..	7,750,540	21,104,483	7,285,005	23,465,197
Potash (K_2O).....short tons..	25	14,077	(a)	(a)
Pyrites.....long tons..	13,218	29,557	9,845	40,215
Salt.....short tons..	1,026,803	2,839,575	1,089,887	3,273,390
Sand and gravel.....do....	6,192,602	4,375,549	6,001,240	4,939,604
Sand and sandstone (finely ground).....do....	(a)	(a)	....	....
Sand-lime brick.....	....	(a)	....	(a)
Stone.....	....	6,486,605	....	7,917,740
Sulphuric acid [e].....short tons..	196,079	2,501,029	(e)	(e)
Miscellaneous [f].....	....	324,048	....	325,881
Total value, eliminating duplications.....	....	217,671,746	....	246,162,215

[a] Value included under "Miscellaneous."
[b] Exclusive of natural cement, value for which is included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Figures of quantity not available for 1917.
[e] From zinc smelting. Canvass discontinued after 1917.
[f] 1917: Bromine, calcium chloride, sand and sandstone (finely ground), and sand-lime brick; 1918: Asphalt, bromine, calcium chloride, natural cement, potash, and sand-lime brick.

Mineral production of Oklahoma in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Asphalt:				
Natural.....short tons..	5,793	$34,344	115,848	$1,382,988
Oil.....do....	(a)	(a)		
Cement.....barrels..	1,736,761	2,633,479	1,218,841	2,203,041
Clay products.....	....	1,857,546	....	1,496,490
Coal.....short tons..	4,386,844	12,335,413	4,813,447	17,508,884
Coke.....do....	....	....	(ab)	(ab)
Gypsum.....do....	158,017	562,767	126,208	637,644
Lead.....do....	26,358	4,533,576	56,097	7,965,774
Lime.....do....	(a)	(a)	(a)	(a)
Mineral paints, zinc and lead pigments.....do....	(ab)	(ab)	(ab)	(ab)
Mineral waters.....gallons sold..	852,381	26,997	1,166,485	20,249
Natural gas.....M cubic feet..	137,384,154	13,984,656	124,317,179	15,805,135
Natural-gas gasoline.....gallons.	115,123,424	21,541,905	163,700,550	28,389,045
Petroleum.....barrels..	107,507,471	181,646,981	103,347,070	231,136,205
Salt.....short tons..	(a)	(a)	(a)	(a)
Sand and gravel.....do....	463,233	244,432	383,747	215,862
Stone.....	....	625,048	....	696,195
Tripoli.....short tons..	(c)	(c)	(c)	(c)
Zinc.....do....	85,835	17,510,340	161,401	29,374,982
Miscellaneous [d].....	....	1,721,273	....	537,211
Total value, eliminating duplications.....	....	259,134,377	....	336,857,921

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Included in Missouri figures. Not separable.
[d] 1917: Oil asphalt, lime, zinc and lead pigments, and salt; 1918: Coke, lime, zinc and lead pigments, and salt.

Mineral production of Oregon in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Asbestos..........short tons..	....	....	(a)	(a)
Briquets, fuel..........do....	(ab)	(ab)	(ab)	(ab)
Cement..........barrels..	(a)	(a)	(a)	(a)
Chromite..........long tons..	6,701	$164,032	18,454	$855,050
Clay products..........	....	c 331,546	....	c 232,564
Clay, raw..........short tons..	(ab)	(ab)	(ab)	(ab)
Coal..........do....	28,327	95,663	13,828	37,454
Copper..........pounds..	2,474,487	675,535	2,451,016	605,401
Ferroalloys..........long tons..	....	....	(ab)	(ab)
Gems and precious stones..........	....	3,355	....	780
Gold..........fine ounces (troy)..	72,166	1,491,798	61,459	1,270,465
Gypsum..........short tons..	(a)	(a)	(a)	(a)
Lead..........do....	....	....	5	753
Lime..........do....	4,498	40,065	2,257	26,884
Manganese ore..........long tons..	....	....	198	(a)
Mineral waters..........gallons sold..	13,741	2,842	13,550	1,825
Natural gas..........M cubic feet..	....	....	2,200	550
Platinum and allied metals......fine ounces (troy)..	89	9,208	65	7,185
Quicksilver..........flasks..	388	40,864	702	82,485
Sand and gravel..........short tons..	698,351	242,529	473,745	193,559
Silver..........fine ounces (troy)..	125,656	103,541	107,323	107,323
Stone..........	....	413,867	....	233,521
Tungsten ore (60 per cent concentrates)..short tons..	....	71	....	....
Miscellaneous[d]..........	....	533,862	....	804,675
Total value, eliminating duplications..........	....	4,074,247	....	4,191,740

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Exclusive of pottery, value for which is included under "Miscellaneous."
[d] 1917: Fuel briquets, cement, pottery, raw clay, and gypsum; 1918: Asbestos, fuel briquets, cement, pottery, raw clay, ferroalloys, gypsum, and manganese ore.

Mineral production of Pennsylvania in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Briquets, fuel..........short tons..	84,394	a $265,979	143,294	a $588,569
Bromine..........pounds..	(b)	(b)	....	....
Calcium chloride..........short tons..	(b)	(b)	....	....
Cement..........barrels..	c 27,709,442	c 34,512,388	c 22,238,689	c 33,600,956
Clay products..........	....	38,743,105	....	40,467,104
Clay, raw..........short tons..	511,405	a 1,365,870	591,685	a 1,697,228
Coal:				
Anthracite..........do....	99,611,811	283,650,723	98,826,084	336,480,347
Bituminous..........do....	172,448,142	421,268,808	178,550,741	463,159,736
Coke..........do....	27,912,025	a 135,698,040	26,723,645	a 160,357,274
Copper..........pounds..	459,200	125,362	779,393	192,510
Feldspar..........short tons..	10,013	91,208	4,916	57,269
Ferroalloys..........long tons..	356,462	a 53,980,132	448,204	a 72,897,550
Gems and precious stones..........	....	(b)	....	(b)
Graphite, crystalline..........pounds..	804,945	77,475	1,016,900	112,059
Iron ore:				
Sold to furnaces..........long tons..	548,674	873,320	515,845	982,173
Sold for paint..........do....	(b)	(b)	....	....
Iron, pig..........do....	15,423,262	a 460,677,474	14,701,252	a 465,859,029
Lime..........short tons..	936,209	5,900,056	801,884	6,654,407
Marl (calcareous)..........do....	(b)	(b)	(b)	(b)
Millstones..........	....	(b)	....	(b)
Mineral paints, zinc and lead pigments...short tons..	(a b)	(a b)	(a b)	(a b)
Mineral waters..........gallons sold..	1,603,090	147,021	1,400,456	123,436
Natural gas..........M cubic feet..	133,397,206	28,716,492	123,813,358	38,608,883
Natural-gas gasoline..........gallons..	13,826,250	2,778,098	15,775,058	3,249,233
Peat..........short tons..	(b)	(b)	(b)	(b)
Pebbles for grinding..........do....	....	....	(b)	(b)
Petroleum..........barrels..	7,733,200	25,154,290	7,407,812	29,606,079
Potash (K_2O)..........short tons..	280	91,505	348	148,590
Pyrites..........long tons..	(b)	(b)	(b)	(b)

[a] Value not included in total value for State.
[b] Value included under "Miscellaneous."
[c] Exclusive of natural cement, value for which is included under "Miscellaneous."

Mineral production of Pennsylvania in 1917 and 1918—Continued.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Salt .... short tons..	(a)	(a)		
Sand and gravel .... do....	6,354,635	$5,283,000	6,302,677	$7,207,840
Sand and sandstone (finely ground) .... do....	(a)	(a)	(a)	(a)
Sand-lime brick		83,123		(a)
Silica (quartz) .... short tons..	113,346	80,699	(a)	(a)
Slate		3,306,704		2,304,647
Stone		14,048,158		15,783,147
Sulphuric acid [b] .... short tons..	274,932	4,407,588	(b)	(b)
Talc .... do....	(a)	(a)	(a)	(a)
Tripoli (rottenstone) .... do....	(a)	(a)	(a)	(a)
Miscellaneous [c]		22,856,328		22,098,633
Total value, eliminating duplications		869,800,965		979,245,098

[a] Value included under "Miscellaneous."

[b] From zinc smelting. Canvass discontinued after 1917.

[c] 1917: Bromine, calcium chloride, natural cement, gems and precious stones, iron ore sold for paint, calcareous marl, millstones, zinc and lead pigments, peat, pyrites, salt, sand and sandstone (finely ground), talc, and tripoli (rottenstone); 1918: Natural cement, gems and precious stones, calcareous marl, millstones, zinc and lead pigments, peat, pebbles for grinding, pyrites, sand and sandstone (finely ground), sand-lime brick, silica (quartz), talc, and tripoli (rottenstone).

Mineral production of Rhode Island in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Clay products		(a)		(a)
Graphite, amorphous .... short tons..	(a)	(a)	(a)	(a)
Lime .... do....	(a)	(a)	(a)	(a)
Mineral waters .... gallons sold..	368,976	$24,975	365,705	$30,729
Sand and gravel .... short tons..	(a)	(a)	(a)	(a)
Stone		518,785		577,404
Miscellaneous [b]		173,363		152,564
Total value, eliminating duplications		717,123		760,787

[a] Value included under "Miscellaneous."

[b] Clay products, amorphous graphite, lime, and sand and gravel.

Mineral production of South Carolina in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Barytes .... short tons..	(a)	(a)	(a)	(a)
Clay products		$662,801		$605,768
Clay, raw .... short tons..	40,448	[b] 173,706	38,311	[b] 262,878
Gems and precious stones		(a)		
Gold .... fine ounces (troy)..	52	1,083		
Manganese ore .... long tons..	405	(a)	100	(a)
Manganiferous ore .... do.....	650	(a)	850	(a)
Marl, calcareous .... short tons..	(a)	(a)	(a)	(a)
Mica				(a)
Mineral waters .... gallons sold..	289,094	45,729	279,300	51,198
Phosphate rock .... long tons..	33,485	138,482	37,040	164,650
Pyrites .... do.....			(a)	(a)
Sand and gravel .... short tons..	98,068	42,162	76,297	49,374
Silver .... fine ounces (troy)..	3	2		
Stone		427,531		599,964
Tin (metallic equivalent) .... short tons..				300
Miscellaneous [c]		75,507		87,289
Total value, eliminating duplications		1,393,297		1,558,543

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] 1917: Barytes, gems and precious stones, manganese and manganiferous ores, and calcareous marl; 1918: Barytes, manganese and manganiferous ores, calcareous marl, mica, and pyrites.

Mineral production of South Dakota in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Clay products		$47,213		$32,161
Clay, raw .... short tons	(a b)	(a b)	(a b)	(a b)
Coal .... do	8,042	23,346	7,942	22,230
Columbite (50 per cent Ta_2O_5) .... pounds			4,500	2,250
Copper .... do	10,707	2,923	64,806	16,007
Gems and precious stones				(a)
Gold .... fine ounces (troy)	356,245	7,364,233	317,598	6,565,337
Gypsum .... short tons	(a)	(a)	(a)	(a)
Lead .... do	34	5,855	27	3,792
Lime .... do	4,463	37,589	4,772	40,490
Lithium minerals .... do	(a)	(a)	1,755	37,100
Manganese ore .... long tons			31	(a)
Mica		11,008		(a)
Mineral waters .... gallons sold	443,167	13,545	454,865	17,269
Natural gas .... M cubic feet	(a)	(a)	42,186	19,109
Pyrites .... long tons	(a)	(a)	(a)	(a)
Sand and gravel .... short tons	194,520	49,654	229,787	48,362
Sand-lime brick		(a)		13,617
Silver .... fine ounces (troy)	186,765	153,894	159,202	159,202
Stone		182,907		97,894
Tin (metallic equivalent) .... short tons	10	12,300		200
Tungsten ore (60 per cent concentrates) .... do	270	299,644	201	247,100
Miscellaneous [c]		147,062		123,611
Total value, eliminating duplications		8,348,684		7,441,981

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] 1917: Raw clay, gypsum, lithium minerals, natural gas, pyrites, and sand-lime brick; 1918: Raw clay, gems and precious stones, gypsum, manganese ore, mica, and pyrites.

Mineral production of Tennessee in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Aluminum .... pounds	(a b)	(a b)	(a b)	(a b)
Barytes .... short tons	16,972	$79,058	22,542	$141,844
Bauxite .... long tons	(a)	(a)	(a)	(a)
Cement .... barrels	(a)	(a)	(a)	(a)
Clay products		1,969,226		2,791,867
Clay, raw .... short tons	106,535	[b] 280,136	88,962	[b] 350,333
Coal .... do	6,194,221	13,592,998	6,831,048	19,305,203
Coke .... do	411,326	[b] 2,031,272	427,106	[b] 3,176,614
Copper .... pounds	16,033,749	4,377,213	14,799,680	3,655,521
Ferroalloys .... long tons	30,987	[b] 1,445,132	37,366	[b] 2,586,524
Flint lining for tube mills .... short tons	(a)	(a)	1,335	25,034
Gold .... fine ounces (troy)	258	5,326	235	4,866
Iron ore .... long tons	520,460	1,235,718	408,954	1,184,546
Iron, pig .... do	346,638	[b] 9,102,441	342,538	[b] 11,672,606
Lead .... short tons	2,531	435,326	1,705	242,139
Lime .... do	101,836	504,599	106,527	682,450
Manganese ore .... long tons	1,996	75,066	4,162	153,830
Manganiferous ore .... do	83	(a)	2,358	43,545
Mineral waters .... gallons sold	758,193	47,362	990,027	53,367
Natural gas .... M cubic feet	10,900	2,450	1,826,725	361,140
Petroleum .... barrels	12,196	28,448	8,374	21,704
Phosphate rock .... long tons	506,679	2,101,040	363,737	1,849,546
Potash .... short tons	6	5,000	(a)	(a)
Pyrites .... long tons	(a)	(a)	(a)	(a)
Sand and gravel .... short tons	885,957	489,577	986,801	639,373
Sand and sandstone (finely ground) .... do	(a)	(a)		
Silica (quartz) .... do			(a)	(a)
Silver .... fine ounces (troy)	99,053	81,619	93,620	93,620
Slate		(a)		(a)
Stone		1,635,573		1,493,858
Sulphuric acid (60° Baumé)[c] .... short tons	(a)	(a)	(c)	(c)
Zinc .... do	28,498	5,813,501	21,071	3,834,859
Miscellaneous [d]		13,148,928		8,413,594
Total value, eliminating duplications		36,910,448		39,229,614

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] From copper smelting. Canvass discontinued after 1917.
[d] 1917: Aluminum, bauxite, cement, flint lining for tube mills, manganiferous ore, pyrites, sand and sandstone (finely ground), slate, and sulphuric acid from copper smelting; 1918: Aluminum, bauxite, cement, potash, pyrites, silica (quartz), and slate.

Mineral production of Texas in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Asphalt:				
Natural ... short tons	(a)	(a)	109,761	$1,642,218
Oil ... do	160,739	$2,292,036		
Cement ... barrels	2,358,944	3,661,328	1,918,919	3,297,977
Clay products		3,451,806		3,026,559
Clay, raw ... short tons	4,446	[b] 26,477	2,980	[b] 13,879
Coal ... do	2,355,815	4,177,608	2,261,135	5,937,997
Copper ... pounds	23,132	6,315	9,308	2,299
Fuller's earth ... short tons	(a)	(a)	(a)	(a)
Gems and precious stones		(a)		(a)
Gold ... fine ounces (troy)	1	22	1	25
Graphite, crystalline ... pounds	(a)	(a)	(a)	(a)
Gypsum ... short tons	257,328	996,262	157,388	834,560
Iron ore ... long tons			(a)	(a)
Lead ... short tons	1	214	13	1,913
Lime ... do	52,742	361,308	45,206	363,022
Manganese ore ... long tons	25	(a)	380	(a)
Manganiferous ore ... do	135	(a)		
Mineral waters ... gallons sold	541,178	72,175	544,183	80,553
Natural gas ... M cubic feet	17,047,292	3,192,625	13,439,624	5,027,449
Natural-gas gasoline ... gallons	6,920,405	1,149,441	7,326,122	1,214,565
Petroleum ... barrels	32,413,287	42,891,555	38,750,031	74,867,537
Quicksilver ... flasks	10,791	1,136,508	8,451	992,992
Salt ... short tons	85,181	564,029	79,657	762,006
Sand and gravel ... do	1,580,939	716,457	1,175,426	519,446
Sand-lime brick		65,102		27,384
Silver ... fine ounces (troy)	595,789	490,930	576,565	576,565
Stone		697,540		647,287
Strontium ore ... short tons	(a)	(a)		
Sulphur ... long tons	(a)	(a)	(a)	(a)
Zinc ... short tons	11	2,313		
Miscellaneous [c]		10,032,907		9,122,676
Total value, eliminating duplications		75,958,481		108,945,030

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] 1917: Natural asphalt, fuller's earth, gems and precious stones, crystalline graphite, manganese and manganiferous ores, strontium ore, and sulphur; 1918: Fuller's earth, gems and precious stones, crystalline graphite, iron ore, manganese ore, and sulphur.

Mineral production of Utah in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Antimony ore ... short tons	25	$3,325		
Asphalt ... do	35,192	569,325	31,072	$663,258
Cement ... barrels	899,599	1,461,689	549,593	923,155
Clay products		797,177		[a] 610,288
Clay, raw ... short tons	4,079	[b] 8,298	7,533	[b] 22,528
Coal ... do	4,125,230	8,531,382	5,136,825	13,937,097
Coke ... do	(b c)	(b c)	(b c)	(b c)
Copper ... pounds	246,674,153	67,342,044	227,169,630	56,110,899
Diatomaceous earth ... short tons	(c)	(c)	(c)	(c)
Fluorspar ... do			20	(c)
Gems and precious stones		(c)		(c)
Gold ... fine ounces (troy)	162,306	3,355,156	142,666	2,949,170
Gypsum ... short tons	(c)	(c)	(c)	(c)
Iron ore ... long tons	48,058	(c)	52,722	168,438
Lead ... short tons	89,261	15,352,888	83,504	11,857,584
Lime ... do	9,130	63,574	7,844	67,642
Manganese ore ... long tons	4,195	118,927	5,100	140,038
Manganiferous ore ... do	136	(c)		
Molybdenum ... pounds	(c)	(c)		
Natural gas ... M cubic feet			(c)	(c)
Phosphate rock ... long tons	(c)	(c)	(c)	(c)
Potash (K_2O) ... short tons	3,144	1,234,719	3,864	1,841,124
Salt ... do	79,195	352,145	94,204	580,375

[a] Exclusive of pottery, value for which is included under "Miscellaneous."

[b] Value not included in total value for State.

[c] Value included under "Miscellaneous."

Mineral production of Utah in 1917 and 1918—Continued.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Sand and gravel........................short tons..	307, 596	$82, 707	184, 719	$103, 873
Silver..........................fine ounces (troy)..	13, 479, 133	11, 106, 806	13, 455, 597	13, 455, 597
Slate granules..........................short tons..	(a)	(a)	(a)	(a)
Stone..	....	305, 968	....	355, 579
Sulphuric acid (60° Baumé)[b]............short tons..	(a)	(a)	(b)	(b)
Tungsten ore (60 per cent concentrates).......do....	33	36, 085	7	8, 300
Uranium and vanadium ores..............................	....	29, 173	....	63, 000
Zinc......................................short tons..	10, 643	2, 171, 261	9, 200	1, 674, 347
Miscellaneous[c]..	....	2, 411, 859	....	3, 331, 249
Total value, eliminating duplications..........	....	113, 433, 596	....	105, 622, 712

[a] Value included under "Miscellaneous."
[b] From copper smelting. Canvass discontinued after 1917.
[c] 1917: Coke, diatomaceous earth, gems and precious stones, gypsum, iron ore, manganiferous ore, molybdenum, phosphate rock, slate granules, and sulphuric acid from copper smelting; 1918: Pottery, coke, diatomaceous earth, fluorspar, gems and precious stones, gypsum, natural gas, phosphate rock, and slate granules.

Mineral production of Vermont in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Clay products..	....	$98, 344	....	$87, 609
Clay, raw................................short tons..	2, 766	[a] 27, 032	(a b)	(a b)
Copper......................................pounds..	153, 900	42, 014	1, 116, 384	275, 747
Gold...........................fine ounces (troy)..	3	71	4	83
Lime.....................................short tons..	46, 169	364, 071	35, 728	382, 363
Mineral waters.........................gallons sold..	94, 500	17, 705	95, 700	17, 090
Sand and gravel........................short tons..	51, 827	40, 624	47, 059	10, 462
Scythestones................................do....	(b)	(b)	(b)	(b)
Silver...........................fine ounces (troy)..	497	410	3, 440	3, 440
Slate..	....	1, 858, 307	....	1, 279, 987
Slate granules..........................short tons..			(b c)	(b c)
Stone..	....	5, 920, 799	....	5, 505, 895
Talc and soapstone.....................short tons..	93, 960	625, 150	90, 612	778, 012
Miscellaneous..	....	13, 078	....	846, 366
Total value, eliminating duplications..........	....	8, 980, 573	....	9, 158, 945

[a] Value not included in total value for State.
[b] Value included under "Miscellaneous."
[c] Value of New York production included with Vermont. Not separable.

Mineral production of Virginia in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Asbestos.................................short tons..	(a)	(a)	....	....
Barytes.......................................do....	(a)	(a)	(a)	(a)
Briquets, fuel................................do....	(a b)	(a b)	(a b)	(a b)
Cement.......................................barrels..	(a)	(a)	(a)	(a)
Clay products..	....	$1,658,042	....	$1,666,854
Clay, raw................................short tons..	3,724	[b] 6,263	9,003	[b] 32,923
Coal..do....	10,087,091	20,125,713	10,289,808	25,865,895
Coke..do....	1,304,230	[b] 5,785,934	1,234,256	[b] 8,046,115
Copper......................................pounds..	36,630	10,000	....	....
Diatomaceous earth.....................short tons..	....	....	(a)	(a)
Emery...do....	(a)	(a)	(a)	(a)
Ferroalloys...............................long tons..	7,217	[b] 1,759,170	40,383	[b] 7,367,035
Gems and precious stones...............................	....	2,677	....	(a)
Gold...........................fine ounces (troy)..	65	1,343	19	400
Gypsum...................................short tons..	(a)	(a)	(a)	(a)
Iron ore..................................long tons..	472,337	1,182,449	400,135	1,365,582
Iron, pig.....................................do....	562,299	[b] 15,703,295	453,863	[b] 15,430,473
Lead.....................................short tons..	859	147,794	815	115,683
Lime..do....	307,195	1,820,446	249,990	1,629,567
Manganese ore.............................long tons..	12,360	588,806	10,928	500,528
Manganiferous ore.............................do....	34,396	185,968	12,776	127,533

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.

Mineral production of Virginia in 1917 and 1918—Continued.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Marl, calcareous...short tons	27,300	$52,850	39,770	$100,518
Mica		25,540		50,490
Millstones		18,980		(a)
Mineral paints, zinc and lead pigments...short tons			(a b)	(a b)
Mineral waters...gallons sold	2,518,050	237,788	1,745,105	173,912
Peat...short tons	(a)	(a)		
Pyrites...long tons	170,382	1,378,043	143,427	841,177
Salt...short tons	(a)	(a)	(a)	(a)
Sand and gravel...do	1,126,527	532,310	1,331,123	764,618
Sand and sandstone (finely ground)...do	(a)	(a)	(a)	(a)
Silver...fine ounces (troy)	4,518	3,723	1,814	1,814
Slate		135,380		109,723
Stone		1,612,118		1,638,077
Talc and soapstone...short tons	26,667	489,062	18,520	597,782
Titanium minerals:				
Ilmenite...do	259	6,576	444	11,100
Rutile...do	206	32,960	261	39,150
Zinc...do	1,708	347,352	951	173,081
Miscellaneous [c]		1,725,817		2,145,596
Total value, eliminating duplications		32,243,648		37,639,368

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] 1917: Asbestos, barytes, fuel briquets, cement, emery, gypsum, peat, salt, and sand and sandstone (finely ground); 1918: Barytes, fuel briquets, cement, diatomaceous earth, emery, gems and precious stones, gypsum, millstones, zinc and lead pigments, salt, and sand and sandstone (finely ground).

Mineral production of Washington in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Briquets, fuel...short tons	(a b)	(a b)	(a b)	(a b)
Cement...barrels	1,403,191	$2,367,045	1,116,754	$2,114,730
Chromite...long tons	(a)	(a)	(a)	(a)
Clay products		1,533,039		c 1,274,708
Clay, raw...short tons	1,613	b 9,248	3,435	b 17,637
Coal...do	4,009,902	10,727,362	4,082,212	14,132,869
Coke...do	(a b)	(a b)	123,788	b 1,196,685
Copper...pounds	2,199,518	600,468	1,922,406	474,834
Diatomaceous earth...short tons	1,995	18,910	(a)	(a)
Ferroalloys...long tons	(a b)	(a b)	(a b)	(a b)
Fluorspar...short tons			(a)	(a)
Gems and precious stones		(a)		(a)
Gold...fine ounces (troy)	23,816	492,324	14,738	304,658
Iron ore...long tons			(a)	(a)
Iron, pig...do	2,361	(a b)	15,780	(a b)
Lead...short tons	4,895	841,913	2,636	374,299
Lime...do	23,328	156,553	22,118	226,104
Magnesite...do	105,175	783,188	147,528	1,050,790
Mineral waters...gallons sold	155,265	7,265	(a)	(a)
Molybdenum...pounds	(a)	(a)		
Natural gas...M cubic feet			(a)	(a)
Platinum and allied metals...fine ounces (troy)	(a)	(a)	10	1,075
Potash (K_2O)...short tons			(a)	(a)
Sand and gravel...do	895,120	199,565	908,102	332,141
Sand-lime brick		(a)		(a)
Silver...fine ounces (troy)	282,320	232,632	310,093	310,093
Stone		454,594		365,098
Strontium ore...short tons	(a)	(a)		
Tungsten ore (60 per cent concentrates)...do	10	13,500	1	800
Zinc...do	598	121,948	19	3,537
Miscellaneous [d]		1,809,700		1,360,720
Total value, eliminating duplications		18,576,052		20,999,691

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] Exclusive of pottery, value for which is included under "Miscellaneous."

[d] 1917: Fuel briquets, chromite, coke, ferroalloys, gems and precious stones, pig iron, molybdenum, platinum and allied metals, sand-lime brick, and strontium ore; 1918: Fuel briquets, chromite, pottery, diatomaceous earth, ferroalloys, fluorspar, gems and precious stones, iron ore, pig iron, mineral waters, natural gas, potash, and sand-lime brick.

Mineral production of West Virginia in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Bromine...pounds..	74,947	$42,431	77,094	$69,606
Calcium chloride...short tons..	3,691	63,644	3,467	57,232
Cement...barrels..	(a)	(a)	(a)	(a)
Clay products...		9,608,065		10,988,677
Clay, raw...short tons..	127,024	[b]189,672	120,437	[b] 216,771
Coal...do....	86,441,667	200,659,368	89,935,839	230,508,846
Coke...do....	3,349,761	[b]16,715,083	3,320,006	[b] 22,152,844
Grindstones and pulpstones...do....	(c)	162,310	7,331	306,042
Iron ore...long tons..	4,632	(a)		
Iron, pig...do....	355,956	(a b)	342,573	(a b)
Lime...short tons..	245,569	1,268,343	167,901	1,194,610
Marl, calcareous...do....	(a)	(a)	(a)	(a)
Mineral waters...gallons sold..	156,267	37,529	301,883	32,045
Natural gas...M cubic feet..	308,617,101	57,389,161	265,160,917	41,324,365
Natural-gas gasoline...gallons..	32,668,647	6,511,813	37,603,903	7,498,804
Petroleum...barrels..	8,379,285	27,246,960	7,866,628	31,652,018
Salt...short tons..	24,844	191,044	26,077	251,668
Sand and gravel...do....	877,679	966,763	904,148	1,438,887
Sand and sandstone (finely ground)...do....	(a)	(a)	(a)	(a)
Stone...		1,841,071		2,024,525
Sulphuric acid [d]...short tons..	(a)	(a)	(d)	(d)
Miscellaneous [e]...		10,141,380		10,609,024
Total value, eliminating duplications...		306,916,191		327,982,620

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Figures of quantity not available for 1917.
[d] From zinc smelting. Canvass discontinued after 1917.
[e] 1917: Cement, iron ore, pig iron, calcareous marl, sand and sandstone (finely ground), and sulphuric acid from zinc smelting; 1918: Cement, pig iron, calcareous marl, and sand and sandstone (finely ground).

Mineral production of Wisconsin in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Barytes...short tons..			(a)	(a)
Briquets, fuel...do....	(a b)	(a b)	(a b)	(a b)
Clay products...		$1,122,121		[c] $874,172
Clay, raw...short tons..	(a b)	(a b)	(a b)	(a b)
Coke...do....	(a b)	(a b)	(a b)	(a b)
Iron ore:				
Sold to furnaces...long tons..	1,179,709	3,913,437	1,167,640	3,796,408
Sold for paint...do....	982	(a)	2,597	5,026
Iron, pig...do....	402,732	[b] 11,032,274	363,225	[b] 13,832,908
Lead...short tons..	4,139	711,908	4,533	613,686
Lime...do....	169,650	1,037,578	109,303	740,700
Mineral paints, zinc and lead pigments...do....	(a b)	(a b)	(a b)	(a b)
Mineral waters...gallons sold..	6,296,634	1,362,498	6,630,725	1,193,315
Potash (K_2O)...short tons..	277	259,928	376	376,586
Pyrites...long tons..	(a)	(a)	(a)	(a)
Sand and gravel...short tons..	3,609,869	1,080,860	2,170,312	809,884
Sand-lime brick...		(a)		(a)
Silica (quartz)...short tons..	(a)	(a)	(a)	(a)
Stone...		2,787,023		2,392,456
Sulphuric acid (60° Baumé) [d]...short tons..	(a)	(a)	(d)	(d)
Zinc...do....	59,742	12,187,368	50,014	9,102,548
Miscellaneous [e]...		9,017,291		11,711,577
Total value, eliminating duplications...		24,976,780		20,091,146

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Exclusive of pottery, value for which is included under "Miscellaneous."
[d] From zinc smelting. Canvass discontinued after 1917.
[e] 1917: Fuel briquets, raw clay, coke, iron ore sold for paint, zinc and lead pigments, pyrites, sand-lime brick, silica (quartz), and sulphuric acid from zinc smelting; 1918: Barytes, fuel briquets, pottery, raw clay, coke, zinc and lead pigments, pyrites, sand-lime brick, and silica (quartz).

Mineral production of Wyoming in 1917 and 1918.

Product.	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Asbestos........short tons..	(a)	(a)		
Chromite........long tons..			263	$5,124
Clay products........		$106,838		110,091
Clay, raw........short tons..	(a b)	(a b)	(a b)	(a b)
Coal........do....	8,575,619	16,593,283	9,438,688	22,581,019
Copper........pounds..	2,027,857	553,605	852,777	210,636
Gems and precious stones........		(a)		(a)
Gold........fine ounces (troy)..	182	3,762	42	871
Gypsum........short tons..	55,844	197,867	41,877	195,143
Iron ore........long tons..	543,846	(a)	447,884	(a)
Lime........short tons..	(a)	(a)	(a)	(a)
Manganese ore........long tons..	30	(a)	42	(a)
Manganiferous ore........do....			50	(a)
Mica........				(a)
Mineral waters........gallons sold..	53,726	7,890	41,335	5,513
Natural gas........M cubic feet..	(a)	(a)	4,338,840	156,171
Natural-gas gasoline........gallons..			1,579,526	268,339
Petroleum........barrels..	8,978,680	11,047,876	12,596,287	18,159,778
Phosphate rock........long tons..	(a)	(a)		
Platinum and allied metals......fine ounces (troy)..	(a)	(a)	(a)	(a)
Sand and gravel........short tons..	(a)	(a)	502,746	50,298
Silver........fine ounces (troy)..	3,415	2,814	965	965
Sodium sulphate from natural sources...short tons..	(a)	(a)	(a)	(a)
Stone........		156,180		182,087
Sulphur........long tons..	(a)	(a)		
Uranium and vanadium ores........				10,322
Miscellaneous [c]........		879,283		661,735
Total value, eliminating duplications........		29,547,428		42,595,812

[a] Value included under "Miscellaneous."

[b] Value not included in total value for State.

[c] 1917: Asbestos, raw clay, gems and precious stones, iron ore, lime, manganese ore, natural gas, phosphate rock, platinum and allied metals, sand and gravel, sodium sulphate from natural sources, and sulphur; 1918: Raw clay, gems and precious stones, iron ore, lime, manganese and manganiferous ores, mica, platinum and allied metals, and sodium sulphate from natural sources.

PREFATORY NOTE TO THE REPORTS ON GOLD, SILVER, COPPER, LEAD, AND ZINC.

By Edson S. Bastin.

In the mining industry five metals are closely related in both the genesis and the geologic occurrence of their ores. They also hold together in mining and in metallurgical treatment. They are gold, silver, copper, lead, and zinc. Of their ores some contain all five metals, many contain three or four, and few contain only one. Gold and silver, for instance, on the one hand, and lead and zinc, on the other, almost always stand in close genetic relations, and the ores of each two are usually mined together. Copper ores almost invariably produce some silver and gold as well as copper, and lead ores, with certain exceptions, produce notable supplies of silver. Zinc ores in the Western States contribute also to the production of silver. In the same mines sometimes, and in the same mining district frequently, all five metals occur in commercial quantity.

This situation is recognized by the United States Geological Survey in its publication of the annual reports on the mineral resources of the country. Hence the general treatment of each of the five metals in the general reports and the grouping together of the related metals in the various mines reports descriptive of individual or geographically grouped States.

To facilitate advance publication, the complete report upon these five metals is therefore divided into 16 sections, each of which is published separately. The first four sections give figures of output for the calendar year in marketable form for the metals named as obtained from the smelters, refineries, and mints and general reviews of the respective industries for the entire country. The last 12 sections give the production (called "mine production") as obtained from the mines so far as possible in terms of recoverable metal in ores and other material sold or treated during the calendar year and supply information in detail relative to the mining industry in the respective States, counties, and mining districts. The figures given in the general reports are the final official statistics of production for the country and of the States. The general report on gold and silver includes the statistics of recovered precious metals as determined jointly by the Bureau of the Mint and the United States Geological Survey.

The 16 sections, which appear as separate chapters in this volume, are as follows:

Gold and silver (general report).
Copper (general report).
Lead (general report).
Zinc (general report).
Gold, silver, copper, lead, and zinc in the Eastern States (mines report).
Silver, copper, lead, and zinc in the Central States (mines report).
Gold, silver, copper, and lead in Alaska (mines report).
Gold, silver, copper, lead, and zinc in Arizona (mines report).
Gold, silver, copper, lead, and zinc in California and Oregon (mines report).
Gold, silver, copper, lead, and zinc in Colorado (mines report).
Gold, silver, copper, lead, and zinc in Idaho and Washington (mines report).
Gold, silver, copper, lead, and zinc in Montana (mines report).
Gold, silver, copper, lead, and zinc in Nevada (mines report).
Gold, silver, copper, lead, and zinc in New Mexico and Texas (mines report).
Gold, silver, copper, and lead in South Dakota and Wyoming (mines report).
Gold, silver, copper, lead, and zinc in Utah (mines report).

In measurements of ores, concentrates, and similar material the short ton of 2,000 pounds is used throughout. The ore classification is necessarily arbitrary, because of the varying factors affecting mining and treatment of ores. An ore is generally understood to be worked at a profit for one or more metals. The dry or siliceous ores comprise gold and silver ores proper, as well as fluxing ores carrying considerable quantities of iron and manganese oxides and very small quantities of gold and silver, and also precious metal bearing ores carrying copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The copper ores include the great disseminated copper deposits of the West and the copper ores of the Lake Superior region, and all ores carrying more than 2.5 per cent of copper. In general, the lead ores are those containing more than 4.5 per cent of lead, and the zinc ores are those containing 25 per cent or more of zinc, both irrespective of their precious-metal content; but some ores of lower grade in lead, and especially in zinc, are treated profitably for these metals, and of course they are then classified as lead or zinc ores, as the case may be. The mixed ores are combinations of the ores enumerated.

The prices used by the United States Geological Survey for calculation of values for the years 1850–1918, inclusive, are as follows:

Prices of silver, copper, lead, and zinc, 1850–1918.

Year.	Silver.[a]	Copper.[b]	Lead.[c]	Zinc.[d]
	Fine oz.	*Pound.*	*Pound.*	*Pound.*
1850	$1.32	$0.22	$0.05	....
1851	1.34	.166	.05	....
1852	1.33	.22	.05	....
1853	1.35	.22	.06	$0.055
1854	1.35	.22	.06	....
1855	1.34	.27	.07	....
1856	1.34	.27	.066	....
1857	1.35	.25	.06	....
1858	1.34	.23	.06	....
1859	1.36	.22	.055	....
1860	1.35	.23	.056	....
1861	1.33	.22	.05	....
1862	1.35	.22	.06	....
1863	1.345	.34	.06	....
1864	1.345	.47	.07	.139
1865	1.337	.392	.066	....
1866	1.339	.342	.07	....
1867	1.33	.254	.065	....
1868	1.326	.23	.065	....
1869	1.325	.242	.06	....
1870	1.328	.212	.06	....
1871	1.325	.241	.06	....
1872	1.322	.356	.064	....
1873	1.297	.280	.06	....
1874	1.278	.220	.06	....
1875	1.24	.227	.058	.07
1876	1.16	.21	.061	.072
1877	1.20	.19	.055	.06
1878	1.15	.166	.036	.049
1879	1.12	.186	.041	.052
1880	1.15	.214	.05	.055
1881	1.13	.182	.048	.052
1882	1.14	.191	.049	.053
1883	1.11	.165	.043	.045
1884	1.11	.13	.037	.044
1885	$1.07	$0.108	$0.040	$0.043
1886	.99	.111	.046	.044
1887	.98	.138	.045	.046
1888	.94	.168	.044	.049
1889	.94	.135	.039	.05
1890	1.05	.156	.045	.055
1891	.99	.128	.043	.05
1892	.87	.116	.041	.046
1893	.78	.108	.037	.04
1894	.63	.095	.033	.035
1895	.65	.107	.032	.036
1896	.68	.108	.03	.039
1897	.60	.12	.036	.041
1898	.59	.124	.038	.046
1899	.60	.171	.045	.058
1900	.62	.166	.044	.044
1901	.60	.167	.043	.041
1902	.53	.122	.041	.048
1903	.54	.137	.042	.054
1904	.58	.128	.043	.051
1905	.61	.156	.047	.059
1906	.68	.193	.057	.061
1907	.66	.20	.053	.059
1908	.53	.132	.042	.047
1909	.52	.13	.043	.054
1910	.54	.127	.044	.054
1911	.53	.125	.045	.057
1912	.615	.165	.045	.069
1913	.604	.155	.044	.056
1914	.553	.133	.039	.051
1915	.507	.175	.047	.124
1916	.658	.246	.069	.134
1917	.824	.273	.086	.102
1918	1.00	.247	.071	.091

[a] Report of Director of the Mint, pp. 212–213, 1914. Equivalent value of fine ounce based on average price and average rate of exchange. For 1916 and 1917, dealers' buying price, New York. For 1918 average price supplied by the Bureau of the Mint.

[b] Weed, W. H., Copper handbook, vol. 11, pp. 1339, 1343, for years 1850–1903. By computation from data for years 1850–1860, p. 1339. Survey computations for electrolytic copper since 1904. For 1916, 1917, and 1918, sales price, all marketable grades.

[c] New York price, Ingalls, W. R., Lead and zinc in the United States, p. 203, 1908. U. S. Geological Survey since 1904. For 1916 outside spot quotations, New York. For 1917 and 1918 average sales price, all grades.

[d] New York price, 1875–1904, Ingalls, W. R., Lead and zinc in the United States, p. 342, 1908. St Louis price, U. S. Geological Survey since 1904. The zinc price for 1915, 1916, 1917, and 1918 is average sales price for zinc, all grades. Oral communication from C. E. Siebenthal for 1853, and 1864.

It is to be understood, of course, that market values are not received by producers for metals in ore and intermediate products, nor always for metals in marketable form, that payment is made in accordance with contracts for treatment or sale, and that, therefore, average daily quotations do not necessarily agree with average prices received.

Each of the 16 sections mentioned is published in a separate pamphlet for advance distribution, and copies can be obtained, as long as the supply lasts, on request made to the Director, United States Geological Survey, Washington, D. C.

CADMIUM.

By C. E. Siebenthal.

INTRODUCTION.

The war interest in cadmium centered mainly in its use as a substitute for tin, but its greatest use was probably in bronze telegraph and telephone wires.

The heavy consumption of tin in the manufacture of food containers for rationing the American and allied armies, combined with the lack of shipping and the loss of several cargoes of tin, resulted in a scarcity of tin in this country and led to governmental control of its distribution as well as to a campaign for its conservation. One method of saving tin is to substitute cadmium for it in solder. In the last year of the war the Government and certain large concerns began studies of cadmium solders as a means of conserving the tin supply. The results of these studies are promising, but the demand for tin decreased and the armistice was signed before this use of cadmium attained much commercial importance.

About 600 tons of cadmium accumulates annually in this country as dusts and residues, by-products of the lead and zinc industries, and about 100 tons of metallic cadmium is recovered from these by-products. If all the cadmium dusts and residues were treated, the output of metallic cadmium would be small in comparison to the 19,000 or 20,000 tons of tin annually used in this country in solder, even if due allowance is made for the fact that 1 pound of cadmium can replace from 3 to 5 pounds of tin.

The first of the belligerent nations to substitute cadmium for tin on a considerable scale was Germany, which was cut off almost entirely from the world's tin supplies by the blockade. The great scarcity of tin in Germany is indicated by the fact that more than 30 per cent of the cargo of the submarine *Deutschland*, on her return trip in July, 1916, consisted of pig tin. Solders containing 10 per cent of cadmium were used in Germany early in the war, and some were reported to contain as high as 30 per cent of cadmium and only 2 per cent of tin instead of the customary 40 or 50 per cent. Nickel was also scarce in Germany and made up a large part of both return cargoes carried by the *Deutschland*, and it is likely that cadmium plating was substituted for nickel plating as far as possible.

Cadmium was used by European nations during the war for some strictly military purposes, but little exact information is available in regard to these uses.

PRODUCTION.

A brief account of the production, resources, metallurgy, and uses of cadmium was given as a chapter in Mineral Resources, 1908. A more detailed report is in preparation and will be published as a bulletin of the United States Geological Survey. The present report gives the production of cadmium in the United States since the beginning of the industry in 1907, the chief sources of the metal in the United States, the principal uses, the imports for 1903 and later years, the range of fluctuation in price in 1918, and the yearly average selling price since 1907.

Cadmium was first produced in the United States by the Grasselli Chemical Co. in 1907. One by one other companies began the recovery of cadmium until there are now six producing plants, as follows: American Smelting & Refining Co., Grasselli Chemical Co., Krebs Pigment & Chemical Co., Midland Chemical Co., and United States Smelting, Refining & Mining Co. (including the lead smelter at Midvale, Utah, and the electrolytic zinc plant at Kennett, Calif.). To these may shortly be added the Anaconda Copper Mining Co. (electrolytic zinc plant at Great Falls, Mont.); the Judge Mining & Smelting Co., at Park City, Utah; the E. I. duPont de Nemours & Co., at Wilmington, Del.; and the Consolidated Smelting & Refining Co. (Ltd.), of Trail, B. C., with the possibility of still others. Several plants producing cadmium-bearing residues have sold them to other companies already equipped to recover the metal. This points the way to custom cadmium-reduction plants large enough to handle economically the product of those companies whose output is too small to justify individual reduction plants.

Cadmium is produced in the United States in two forms—metallic cadmium and the pigment, cadmium sulphide. The domestic production of metallic cadmium in 1907 was nearly sufficient to supply the home demand, a fact shown by the small imports for that year (see p. 3), but in 1908 the quantity of cadmium imported was almost doubled, and in 1909–1912 the imports were back at the figures that prevailed before cadmium had been produced in the United States. Since 1912, however, the domestic production has made great strides, and as a result the imports of cadmium are again small. As the imports came largely from Germany they have been practically stopped for the last five years.

The following table, compiled from reports by each producer of cadmium in the United States and from official reports of the German Government, shows that the production of cadmium in the United States since 1910 has gained rapidly on that of Germany. Taken together the production of these two countries has constituted practically the whole cadmium production of the world, though a small output is being made at the electrolytic zinc plants of Brunner, Mond & Co. and Chance & Hunt in England, and some cadmium will doubtless be produced at the electrolytic zinc plant at Hobart, Tasmania.

Metallic cadmium and cadmium sulphide produced in the United States and Germany, 1907–1918.

Year.	United States.						Germany.		
	Metallic cadmium.			Cadmium sulphide.			Metallic cadmium.		
	Quantity (pounds).	Value.	Average price per pound.	Quantity (pounds).	Value.	Average price per pound.	Quantity (pounds).	Value.	Average price per pound.
1907	14,000	$14,350	$1.025	(a)	....	....	72,639	$60,757	$0.84
1908	8,000	6,000	.75	(a)	....	....	72,741	48,590	.67
1909	5,300	2,783	.525	(a)	....	....	81,982	46,777	.57
1910	4,700	2,585	.55	(a)	....	....	90,516	39,309	.43
1911	26,152	17,566	.67	2,392	$1,674	$0.70	93,861	53,372	.57
1912	52,508	39,875	.76	8,998	6,400	.71	94,262	63,507	.67
1913	54,198	41,838	.77	17,302	12,136	.70	81,993	63,641	.78
1914	[b] 91,409	81,205	.89	22,723	20,241	.88	(c)	....	....
1915	91,415	108,443	1.19	10,624	12,057	1.13	(c)	....	....
1916	135,212	210,931	1.56	22,176	27,942	1.26	(c)	....	....
1917	207,408	305,097	1.47	50,169	70,939	1.41	(c)	....	....
1918	127,164	188,203	1.48	51,702	70,315	1.36	(c)	....	....
	817,466	1,018,876	....	186,086	221,704	....	....	....	....

[a] No production.
[b] Exclusive of 4,225 pounds of cadmium in residues sold for export.
[c] No figures showing the cadmium production in Germany later than 1913 are available.

The market for metallic cadmium was not good in the first half of 1918, and considerable stocks accumulated, amounting to 161,000 pounds on August 31. Production was somewhat curtailed before August but more sharply curtailed after that time. The output during the first eight months of the year was 118,700 pounds of metallic cadmium and 36,500 pounds of cadmium sulphide, but for the last four months it was only 8,464 pounds of metallic cadmium and 15,202 pounds of cadmium sulphide.

SOURCES.

There are several cadmium minerals, but none of them occur in profitable quantities as ores. The cadmium of commerce is derived from zinc minerals and ores, in almost all of which it occurs in minute quantity, the ratio being about 1 of cadmium to 200 of zinc. Cadmium behaves metallurgically almost the same as zinc and hence constitutes a fraction of 1 per cent of almost all spelter. The sources of cadmium that have been utilized are zinc ores treated by fractional distillation, lead-furnace bag-house "fumes," and residues from the purification vats of electrolytic zinc plants and lithopone plants.

FRACTIONAL DISTILLATION OF ZINC ORES.

Prior to the beginning of production in the United States, cadmium was made principally by Germany, where it was derived from zinc ores chiefly by the method of fractional distillation, which has never been practised to any extent in the United States. As cadmium has a higher volatility than zinc, the first vapor to distill over, which is ordinarily caught as "blue powder," contains a greater proportion of cadmium, than that going over later. This enriched "blue powder" by special treatment has yielded most of Germany's output of cadmium although considerable quantities of cadmium have been recovered from lithopone plant residues beginning with 1908.

In the early years of the war spelter containing more than 0.05 per cent of cadmium was supposed to be unsuitable for cartridge brass. Most spelter distilled in the United States and elsewhere averages from 0.2 to 0.3 per cent of cadmium, the cadmium content ranging from a trace to about 0.75 per cent. The distillers of cadmium-free ores and the electrolytic zinc plants were not able to produce all the high-grade spelter needed for munitions. In this exigency several processes were proposed or revived to remove the cadmium from zinc ores. In one process it was proposed to add carbon to the zinc concentrates near the end of their journey through the long roasting hearth and at the same time to raise the temperature high enough to distill the cadmium, but not high enough to drive off much zinc. The vapor coming off could be collected and further refined to recover the cadmium. Such a process offers a possibility of recovering some part of the 1,200 to 1,400 tons of cadmium contained in the zinc sulphide concentrates produced annually in the Joplin district in 1916–1918. The acceptance of spelter with 0.5 per cent of cadmium as Army "high grade," however, took away the incentive to remove the cadmium, though this process was for a time put into practice at one smelter.

In the latest form of the Woolsey McA. Johnson continuous electrothermic zinc furnace (U. S. patent 1244504, Oct. 30, 1917, described in Met. and Chem. Eng., June 15, 1918, p. 654) the roasted zinc concentrates are passed through a preheater and into the furnace below. In the preheater the concentrates are maintained at a temperature of about 1,050° C., which drives off practically all the cadmium. By this process also a good portion of the cadmium in the Joplin concentrates could be recovered.

LEAD-FURNACE FUMES.

All lead ores contain a certain proportion of zinc. In only one important lead-producing district in the United States, the disseminated lead district of southeastern Missouri, is the quantity of zinc too small to pay to separate it in ore dressing. When lead ores are smelted, the infinitesimal quantity of cadmium in the charge is separated from the associated zinc, the latter going into the slag and the cadmium going over with the fumes and being caught in the bag house, together with the lead and arsenic which were in the fumes. When these fumes have accumulated in sufficient quantity they are ignited and burnt to a clinker. This clinker is charged back into the blast furnace, and the cadmium returns as fumes to the bag house accompanied by the cadmium content of the fresh charge of ore. Thus the cadmium and arsenic contents of the bag-house fumes are constantly augmented while the lead remains practically constant. At one lead smelter, which has been in operation six years, the bag-house dust carries 8 per cent of cadmium. The percentage of cadmium in the bag-house fumes at different smelters ranges from less than 0.1 to 10 or 15 per cent. The rate of enrichment of course depends on the nature of the ore that is being smelted. When the fumes are sufficiently rich in cadmium and arsenic, the arsenic is removed in the arsenic furnace and the residues, which may contain as high as 30 or 40 per cent of cadmium, are treated for the recovery of that metal. Not all lead smelters are equipped with bag houses, and some lead ores contain very little cadmium. Nevertheless the bag-house fumes from lead blast furnaces must in time become enriched to the point where cadmium can be recovered from them. Such fumes have been hitherto the main source of the cadmium produced in this country.

ELECTROLYTIC ZINC-PLANT RESIDUES.

In the reduction of zinc ores by leaching and electrolytic deposition of the zinc, the zinc solution, prior to electrolysis, is cleared of cadmium by precipitation with zinc dust, for the presence of more than 0.05 per cent of cadmium in spelter prevents it being classed as grade A in the Navy specifications. As between a zinc plant and a lead plant treating the same quantity of concentrates the zinc plant would handle from four to ten times as much cadmium because of the greater quantity of zinc involved. It can be seen, therefore, that electrolytic zinc-plant residues will soon be a very important source of cadmium. About one-third of the supply in sight at present will come from the zinc plants. As both the zinc and the cadmium are recovered electrolytically the question of metallurgic supervision is simplified.

From the early part of 1915 until the signing of the armistice, the demand for high-grade spelter for munition making was so great that a considerable quantity of prime western spelter was refined to the high grade either by redistillation or by electrolysis. In electrolysis the anode muds contain the impurities of the original spelter anode, which consist of cadmium, lead, and iron. Some cadmium has been recovered from these muds.

LITHOPONE-PLANT RESIDUES.

In making lithopone the necessary zinc is supplied by dissolving zinc ashes, galvanizer's drosses, refuse zinc oxide, or roasted zinc concentrates in sulphuric acid. The zinc sulphate solution thus obtained must be purified by precipitating out the deleterious ingredients, among which is cadmium. The cadmium residues are concentrated to a usable degree of richness and worked up or sold. The cadmium at lithopone plants is most conveniently recovered in the form of the sulphide.

BRASS-SHOP FUMES.

A competent authority estimates that 3 per cent of the zinc used in brass manufacture escapes in the form of fumes. One-half of this zinc escapes up the flues in the melting and may be precipitated by Cottrell apparatus or otherwise, but the other half escapes into the air in pouring from the melting pots and is lost. The Bureau of Mines estimated several years ago that 400 pounds of cadmium was lost daily in these fumes at Waterbury, Conn. It is likely that the quantity is less now, relatively at least, because of the prevailing wider use in brass making of spelter practically free of cadmium.

The fumes are richer in cadmium than the spelter used, because of the higher volatility of cadmium. They average about 0.2 per cent of lead, 2 per cent of copper, 30 per cent of zinc, and from 1 to 1.5 per cent of cadmium. If such fumes were used in the manufacture of lithopone, the resulting residues would be much richer in cadmium than those obtained when zinc ashes are used.

RESOURCES.

A canvass was made of lead smelters, electrolytic zince reduction and refining plants, lithopone plants, and a few typical brass works, with the object of ascertaining the yearly recovery of cadmium in fumes and residues, the accumulated stocks of such materials, and the maximum yearly capacity of the cadmium-reduction plants. Completeness can not be claimed for the results, but fairly detailed replies were received from the larger producers. Little attention has been paid to the cadmium content of fumes and residues, especially by the operators of plants where it accumulates in small quantity.

According to the data in hand, cadmium is accumulating at lead smelters at the rate of 350 to 400 short tons annually and the stocks of bag-house fumes contain over 750 tons of cadmium. At electrolytic zinc plants about 200 tons is accumulating annually and the stocks of residues contain about 400 tons. At lithopone plants probably 50 tons is produced yearly and about 25 tons is contained in stocks. In round numbers, then, 600 short tons accumulates annually, and there is on hand approximately 1,200 tons in stocks of fumes and residues. Not all the stocks are rich enough for the cadmium to be commercially recovered, but perhaps material that carries 1,000 tons is suitable for treatment. The average recovery of cadmium is about 75 per cent. We may therefore estimate 750 tons of recoverable cadmium in residues in stock. An increase in the number and capacity of electrolytic zinc plants will correspondingly increase the annual accumulation of cadmium.

REDUCTION CAPACITY.

The maximum capacity for metallic cadmium reported by producers is 29,000 pounds a month, or about 175 tons a year. This capacity will be increased by the entrance into the producing list of other electrolytic zinc plants. If the price of cadmium and the demand for it should justify expansion, the producing capacity could no doubt be brought up with reasonable promptness to 500 short tons or more yearly. The price of cadmium will be the deciding factor also in determining what grade of cadmium fumes can be worked at a profit.

IMPORTS.

Cadmium was imported into the United States, before the war, as metallic stick cadmium and as the pigment, cadmium sulphide. The former is free of duty; the latter is dutiable at 30 per cent ad valorem. The value of the imports for consumption of metallic cadmium from 1903 to 1918, inclusive, is given in the table below, which is taken from the records of the Bureau of Foreign and Domestic Commerce. The quantities are not there recorded prior to July, 1909, and for the period preceding that time they have been computed by dividing the values of the imports by the average price of cadmium for the corresponding year in Germany, from which country the cadmium was imported. The quantity and value of cadmium imported as a pigment are not recorded separately by the Bureau of Foreign and Domestic Commerce.

Cadmium imported and entered for consumption in the United States, 1903–1918.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1903	[a]8,679	$4,565	1911	5,367	$3,870
1904	[a]7,655	4,524	1912	5,250	3,764
1905	[a]8,138	5,298	1913	1,656	1,232
1906	[a]13,808	10,522	1914	441	368
1907	[a]1,953	1,633	1915	269	284
1908	[a]3,567	2,390	1916	....	....
1909 first half	[a]6,659	4,559	1917	....	....
1909 second half	2,203		1918	....	....
1910	4,060	2,295			

[a] Prior to July, 1909, the quantities are computed as noted above.

EXPORTS.

Complete statistics of the exports of cadmium before February 1, 1918, are not available, but it is known that domestic cadmium was largely exported during the war. According to the Bureau of Foreign and Domestic Commerce the following quantities of cadmium were exported through the port of New York in the last quarter of 1916: In October, 33,244 pounds, valued at $55,259; in November, 4,900 pounds, valued at $5,100; and in December, 1,044 pounds, valued at $1,530. Of the exports in October, 23,210 pounds went to France, 9,984 pounds to Italy, and 50 pounds to Dutch Guiana.

Between February 1, 1918, and January 31, 1919, 42,320 pounds of metallic cadmium, valued at $63,020, or an average of $1.49 a pound, was licensed for export to the countries listed below, according to information furnished the War Trade Board. Of this quantity, 26,734 pounds was licensed for export before June 30, 1918, and 15,586 pounds between July 1 and December 10, 1918. It is believed that practically all of this cadmium was really exported.

Cadmium licensed for export, Feb. 1, 1918–Jan. 31, 1919.

Destination.	Quantity (pounds).	Value.
Canada	3,025	$4,094
France	30,440	47,960
Great Britain	2,005	2,612
Italy	110	260
Norway	6,740	8,094
	42,320	63,020

Cadmium residues have also been exported, as noted on page 3.

PRICES AND VALUE.

In 1875 cadmium was quoted in the United States at $3.20 a pound. In 1886 the average price for the total output of Germany was 80 cents a pound, but in 1890 and 1892 it fell to 38 cents. In 1897, because of certain purchases by the German Government, the price rose to $1.23 a pound. In 1907, when the United States began making cadmium, the German average price was 84 cents. The price in the United States went down to 53 cents in 1909, but it has been steadily rising since.

The price of cadmium in sticks and small bars in the first quarter of 1918 gradually declined from an average price of $1.75 a pound to $1.40. In April and May the average price was $1.40 and in June and July it was $1.45. For the remainder of the year the quotation was $1.50 a pound. The average price for 1918 as calculated from sales was $1.48, as compared with $1.47 in 1917 and with $1.56 in 1916. The price in London during the first half of 1918 was $1.90 a pound and during the last half year slightly under that figure. The average selling price of cadmium sulphide in the United States in 1918 was $1.36 a pound, as compared with $1.41 in 1917 and with $1.26 in 1916.

The value of the output of cadmium in the United States in 1918, calculated at the average selling price, was $188,203, as compared with $305,097 in 1917, and the value of the cadmium sulphide produced was $70,315, as against $70,939 in 1917.

The total value of the output of metallic cadmium in the United States since the beginning of production in 1907 is $1,018,876 and of cadmium sulphide $221,704, a total of $1,240,580.

USES.

Cadmium is used in metallic form chiefly in alloys, and its various salts are used in the arts, in medicine, and in electroplating.

The National Research Council has formed a committee under the chairmanship of Prof. Charles H. Fulton, of the Case School of Applied Science, "to gather information on cadmium, its properties, production, uses, and possible new uses, and to stimulate research on cadmium."

MISCELLANEOUS CADMIUM ALLOYS.

Cadmium lowers the melting point of alloys in which it is used and is therefore extensively employed in making easily fusible alloys and soft solders, such as those used in the fusible plugs of automatic sprinkler systems. It is also used in making fusible safety plugs for boilers and electric fuses. Cadmium cliché metal is superior to the corresponding bismuth cliché metal for making stereotype plates.

An Austrian patent solder for aluminum (patent 71088–1916) consists of 13 parts of cadmium, 1 part of tin, and 6 parts of zinc.

When the price of zinc was so high in the early part of the war there was some substitution of lead-coated sheets for galvanized sheets. Lead, however, does not adhere readily to iron. The use of a small quantity of cadmium in the lead, less than 1 per cent, makes it possible to cover the iron with a very thin coat or film of lead.

CADMIUM AS A SUBSTITUTE FOR TIN IN SOLDERS.

When tin was so scarce, in the first three-quarters of 1918, there was a general reduction of the quantity of tin in all solder formulas in order to conserve tin and there was an increased use of cadmium as a substitute for tin in solders, such as the half-and-half lead-tin solder. Though cadmium was worth much more than tin it could be profitably substituted for all or a part of the tin in solders because less cadmium than tin and consequently more lead was used. Moreover, the tin supply was needed for uses for which it had no possible substitute.

While the tin scarcity was at its height the possibility was considered of enforcing the largest possible substitution of cadmium for tin. The extent of this substitution is limited by the quantity of cadmium produced and available in reserves. A census was taken, the results of which are given on page 6. In 1917 the consumption of tin in solders alone was more than 19,000 short tons. The possible output of cadmium is so small, compared to this, that only those substitutions which are highly desirable will be made, now that the supply of tin promises to be better.

It was known early in the war that the Germans, without resources in tin but with a fair supply of cadmium, were substituting that metal for tin. It is now known that solders with 10 per cent of cadmium and 10 per cent of tin were used, and that the cadmium content in others ranged as high as 30 per cent, with 2 per cent of tin. It is not likely that much solder from the latter formula was made, however, because Germany's cadmium production is not normally larger than that of the United States, and it probably could not have expanded unduly since in the main it must bear a certain relation to the output of zinc, something like 0.04 per cent.

The properties of lead-tin-cadmium and lead-cadmium solders have been investigated and published by the Bureau of Standards and by the Westinghouse Electric & Manufacturing Co. Unpublished investigations have been made by other laboratories, and an investigation of the toxicity or poisonous properties of cadmium solders is in progress by the Bureau of Chemistry, of the United States Department of Agriculture.

Burgess and Woodward,[1] as the result of experiments at the Bureau of Standards, say:

> Cadmium appears a promising substitute for part of the tin in solders. The Bureau has been developing such a solder, and laboratory tests, together with manufacturing experience, so far point to a composition of 80 lead, 10 tin, 10 cadmium as being practical for many of the purposes for which solder is required. This solder has been tried in the manufacture of tin cans, on roofing materials, and for electrical joints, with encouraging results in all cases. Before using it for food containers, however, it will be necessary to ascertain its toxic properties under various conditions. A test has also been made of it in the manufacture of automobile radiators, with most satisfactory results.

Hill,[2] experimenting at the research laboratory of the Westinghouse Electric & Manufacturing Co., inclines toward a lead-cadmium-zinc solder:

> The use of lead-cadmium solders is complicated by the ease with which cadmium oxidizes. The addition of tin or zinc to lead-cadmium mixtures appears to reduce

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[1] Burgess, G. K., and Woodward, R. W., Bronzes, bearing metals, and solders: Am. Inst. Min. Eng. Bull. 141, pp. 1748-1750, December, 1918.

[2] Hill, C. W., Am. Inst. Min. Eng. Bull. 141, p. 1758, December, 1918.

this tendency toward oxidation, so that these solders may be readily used in iron soldering and if precautions against overheating are taken they may be used in pot soldering.

Zinc is only slightly soluble in lead-cadmium mixtures. Increasing percentages of cadmium increase the tendency to oxidation and raise the cost of the solder without increasing its strength. Most of our experiments have been made with a solder composed of lead 90.8 per cent, cadmium 7.8 per cent, and zinc 1.4 per cent. We have experienced no difficulty in preparing these solders, using the ordinary precautions of solder mixing, They are stronger than the lead-cadmium-tin solders, especially at temperatures above 25° C. At 100° C., they seem to be from 50 to 100 per cent stronger than half-and-half solder and about 30 to 50 per cent stronger than pure tin. The tests were made by pulling apart two copper cylinders that had been soldered end to end. This strength at high temperatures is of value in soldering apparatus that will become heated from one cause or another, such as articles which are to be japanned or are heated by steam. In this respect the lead-cadmium-zinc solders are much superior to lead-cadmium-tin solders.

Hill recommends for further study these three solders:

Composition.	Melting range.
Lead 84.4, cadmium 7.6, tin 5	212°–253° C.
Lead 90.6, cadmium 7.9, zinc 1.5	237°–267° C.
Lead 87.5, cadmium 7.5, zinc 5	235°–368° C.

The cost of material for tin and cadmium solders of various formulas on October 1, is shown in the following:

Cost of material in 100 pounds of solder, Oct. 1, 1918.

	50 parts lead, 50 parts tin.	60 parts lead, 40 parts tin.	80 parts lead, 10 parts tin, 10 parts cadmium.	92 parts lead, 8 parts cadmium.
Lead at 8.05 cents	$4.03	$4.83	$6.44	$7.41
Tin at 80 cents	40.00	32.00	8.00	
Cadmium at $1.50			15.00	12.00
	44.03	36.83	29.44	19.41

At these prices the solder containing 80 parts lead, 10 parts tin, and 10 parts cadmium can be made as cheaply as the half-and-half solder with cadmium at $3 a pound and as cheaply as solder containing 60 parts lead and 40 parts tin with cadmium at $2.25 a pound. The solder containing 92 parts lead and 8 parts cadmium can be made as cheaply as the lead-tin solders with cadmium at $4 and $3.25 a pound, respectively.

By the close of 1918, the lower price of tin and lead made the price of the foregoing solder combinations as follows:

Cost of material in 100 pounds of solder, Dec. 31, 1918.

	50 parts lead, 50 parts tin.	60 parts lead, 40 parts tin.	80 parts lead, 10 parts tin, 10 parts cadmium.	92 parts lead, 8 parts cadmium.
Lead at 5.75 cents	$2.88	$3.45	$4.60	$5.29
Tin at 69 cents	34.50	27.60	6.90	
Cadmium at $1.50			15.00	12.00
	37.38	31.05	26.50	17.29

At average prices before the war of about 4.5 cents a pound for lead, 35 cents for tin, and 80 cents for cadmium, the foregoing solders would cost, respectively, 19.7 cents, 16.7 cents, 15.1 cents, and 10.5 cents a pound for the raw material.

SALTS OF CADMIUM.

The sulphide of cadmium is the brilliant pigment cadmium-yellow or jaune brilliant. Properly prepared it is one of the most permanent pigments known, and it is unaffected by hydrogen sulphide gas from coal smoke, whereas the common yellow pigments (lead chromes) are blackened in a smoky atmosphere. Cadmium-yellow is therefore employed as a protective coating over chrome-yellow in painting street cars and the passenger coaches on some railway lines.

Sulphide of cadmium is extensively used to give color and luster to glass and porcelain, and other cadmium salts are used in dentistry, dyeing, and photography.

Cadmium electroplating is a field that offers some promise of expansion. Cadmium is a better rust preventive than nickel and at more nearly a parity in prices cadmium plating might be substituted for nickel plating in some cases. Or, since it has a greater tendency to tarnish than nickel, it might be used in combination with nickel, the first coat consisting of the rust-preventive cadmium and the second coat of tarnish-proof nickel. It has already been suggested in the introduction to this chapter that owing to the scarcity of nickel in Germany cadmium plating may have been substituted for nickel plating wherever possible.

WAR USES.

Cadmium and cadmium compounds were declared contraband of war by nearly all the belligerents, hence they must have military uses, but naturally there is not much authoritative information about these uses. A fraction of 1 per cent of cadmium is used as a deoxidizer in making bronze telegraph and telephone wires and cables in France and Italy. It is reported that such cables heavily charged with electricity were used in the wire entanglements before the trenches at the front. Cadmium is also said to be used in smoke bombs for signalling. It is also used as a deoxidizer in making nickel alloys and may serve a like purpose in making brass.

It is reported that relatively large quantities of cadmium were exported to Germany before the war for use in making small-arms ammunition. A cadmium band on the hard-jacketed cartridge ball is said to take the rifling with little wear on the barrel and thus prolong the life of the gun. Statistics of exports for the years before the war are not available, but it is reported that Germany as early as 1910 wished to import about 11,000 pounds a month for two years. As this was about twice the total output of the United States for any ante-war year, the order was filled only in part. Paul Speier, of Breslau, the German statistical authority on zinc and cadmium, stated that about 1896 the German Imperial Government used large quantities of cadmium in the artillery and pyrotechnics departments. The journal Metallurgical and Chemical Engineering, in the latter part of 1913, carried this advertisement: "*Cadmium.*—Who can deliver continuously large quantities with analysis? Offers under K. B. 4061 to Rudolf Mosse, Köln a/R., Germany." At the request of the United States Geological Survey the United States consul at Cologne was instructed in January, 1914, to ascertain if possible what use was to be made of this cadmium. Upon inquiry it developed that Mosse was agent for a client who refused to disclose his name. A letter from the consul, forwarded to the client by Mosse, remained unanswered. Inquiries of local metallurgists and chemists in Cologne gained the information that no new uses of cadmium were known by them. As Germany's production in 1913 was 81,993 pounds, compared to 54,198 pounds produced in the United States, it would seem that Germany as early as 1913 was desirous of obtaining control, by purchase or contract, of the cadmium supply of the world.

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MAGNESIUM.

By R. W. STONE.

PRODUCTION.

The output of metallic magnesium in 1918 was 284,118 pounds, valued at $615,217, an increase of 145 per cent in quantity and 163 per cent in value over the output of 1917. The production of magnesium on a commercial scale began in the United States so recently as 1915 and has reached these noteworthy proportions in four years because of unusual conditions.

The figures of production in 1918 are believed to be correct, but those for previous years are not exact, as some of the producers, for lack of data, could report only in round numbers. During 1918 the Geological Survey obtained quarterly reports of the production of magnesium for the information of the Government, as the progress of this industry was of very considerable moment in the conduct of the war. The production was 10,000 to 16,000 pounds greater in each quarter than in the preceding quarter and increased from 50,000 pounds in the first quarter to nearly 90,000 pounds in the last.

Only one firm sold magnesium in the powdered form; hence exact figures of the quantity marketed as sticks and as powder can not be given separately without revealing confidential information. It may be stated, however, that about three-fifths of the total was sold as sticks and two-fifths as powder.

The normal demand for the metal prior to 1915 was for manufacturing the alloy called magnalium and for deoxidizing nonferrous metals; the powdered form was used for flash-light photography and for pyrotechnics. During the war the use of magnesium powder in photography probably did not decrease materially if at all, and a demand new in the United States arose for it—the use in star shells, flares, tracer bullets and other projectiles, as a high explosive ingredient in trench mortar shells, and as an alloy with aluminum in airplane engine and frame castings.

Metallic magnesium produced in the United States, 1915–1918.

Year.	Number of producers.	Quantity (pounds).	Value.	Average price per pound.
1915	3	87,500	$440,000	$5.00
1916	4	75,400	311,462	4.13
1917	5	115,813	233,626	2.02
1918	4	284,118	615,217	[a] 2.16

[a] As 1918 was the first year in which powdered magnesium was reported to the Geological Survey, the average price of $2.16 a pound for all magnesium sold in 1918, which includes a large quantity of powdered magnesium, is not comparable with the average price for 1917, which is based on magnesium in sticks only. The average price for stick magnesium in 1918 was about $1.81 a pound, or 21 cents less than in 1917.

PRODUCERS.

Three plants were producing magnesium at the end of 1918. The American Magnesium Corporation, Niagara Falls, N. Y., was operating a plant at Niagara Falls and one at Rumford, Maine, and the Norton Laboratories (Inc.), Madison Avenue and Forty-first Street, New York City, was operating a plant at Lockport, N. Y. The Dow Chemical Co., Midland, Mich., produced magnesium in the second half of 1918 but ceased production before the end of the year. The Rumford Metal Co., Rumford, Maine, was engaged in producing magnesium during the first half of 1918 but sold the plant to the American Magnesium Corporation, which continued the business to the end of the year. There were therefore four producers and four plants in operation during part of the year, and three plants and two companies operated continuously.

PRICE.

The average price per pound of metallic magnesium in sticks ranged in 1918 from $1.60 to about $2. Magnesium powder brought a higher price, because of the additional fabrication required, and varied in price according to the quantity sold and the fineness of the material.

The variation in price of magnesium during the last few years is interesting to note, because the magnesium industry in the United States is virtually a "war baby." Imported magnesium quoted at about $1.65 a pound supplied the domestic market until the war cut off the foreign supply. Prices rose to $5 or even $6 a pound for sticks and to $6.50 a pound for powdered material. These prices continued through 1915. During 1916 the price fell off, and at the beginning of 1917 99 per cent pure bar magnesium was selling for $2.50 to $3 a pound. This price gradually declined, and at the end of 1917 magnesium in bars was selling for $1.85 to $2 a pound, according to the quantity bought. In 1918 the price of domestic material returned approximately to the pre-war price of imported magnesium.

IMPORTS AND EXPORTS.

The Bureau of Foreign and Domestic Commerce of the Department of Commerce records imports and exports of "barium, calcium, magnesium, sodium, and potassium, and alloys of which said metals are the component material of chief value," in one class, which is subject to a duty of 25 per cent ad valorem. No information is obtained by the customs officials regarding the imports and exports of magnesium alone. It is probable that little or none was imported in 1917. Reports of producers show that between 50,000 and 60,000 pounds was sold to the Allies in 1918.

DEMAND AND SUPPLY.

During 1918 a very large part of the demand for metallic magnesium was for use in war materials, as projectiles, pyrotechnic stores, and airplanes, and came from the governments of the United States, Great Britain, France, and Italy. With the signing of the armistice in November, 1918, there was an abrupt decrease in demand, and the plants whose capacity had been greatly increased to meet war needs had to reduce their output and seek other markets. During the war experiment in the use of magnesium was pushed actively, and new and promising fields were developed. How long it will be before other uses will require as large a quantity of magnesium as that manufactured in 1918 for use in projectiles and war pyrotechnics is a question. Magnesium may not have the meteoric rise in consumption that was enjoyed by aluminum, but, on the other hand, magnesium alloys may find increasing acceptability at such a rate as to utilize in a short time the present productive capacity of the existing plants. Magnesium is a coworker with rather than a competitor of aluminum. It may replace aluminum in one industry but create a much greater use for it in others.

Until 1915 the world's principal source of magnesium was Germany, because that country was a large producer of magnesite and magnesium chloride, materials from which the metal is derived. Since 1915 the United States and Canada, both of which have the raw material, have entered the field and now have plants which, working at full capacity, could produce a large part of the world's normal consumption.

The supply of raw material is inexhaustible. The metal was obtained in 1918 from magnesium chloride derived from bitterns left after the extraction of salt and bromides from brines at Midland, Mich.; from magnesite, the magnesium carbonate, which occurs as veins in serpentine at many localities in California and in beds resembling dolomite near Chewelah, Wash., and Grenville, Quebec, Canada; and from dolomite, the calcium-magnesium carbonate, which occurs abundantly in many places in the United States. Other possible sources of supply are the waters of the oceans and of salt lakes. Ocean water contains only about 0.14 per cent of magnesium, but bitterns made near San Francisco Bay, Calif., by extracting salt from sea water contain from 2.3 to 8.6 per cent of magnesium. Magnesium can and some day may be made from these bitterns.

Several processes for the recovery of magnesium were employed in 1918. Each company has worked out its own method and naturally has not wished to make public the information gained by its own expense and labor.

CHARACTER.

Magnesium is a very light metal resembling silver in color and is prepared in several forms. It comes on the market in cast bars or sticks, square or round, from half an inch to 2 inches thick and from 10 to 20 inches long. The most common size of stick is $1\frac{5}{16}$ inches in diameter and 12 inches long. The metal may also be had as a thin, narrow ribbon, which is made by pressing the semifluid metal into wire and then flattening it. The commonest known form of magnesium is a gray powder which is prepared in different degrees of fineness, particularly 100 to 200 mesh. The purity in any of these forms varies from 99 to 99.9 per cent. The most common impurities are iron, calcium, sodium, potassium, chlorine, and oxygen. Of these, sodium is the most objectionable, especially where the metal is to be used for alloys.

PHYSICAL PROPERTIES.

The values of the physical properties of magnesium given in the sixth revised edition of the Smithsonian Physical Tables are as follows: Atomic weight, 24.32; boiling point, 1,120° C.; coefficient of thermal conductivity (between 0° and 100° C.), 0.3760 cal/cm^3/deg. C./sec.; diffusivity, 0.883; heat of formation (MgO), 143.6 kg-cal; specific heat, 0.2492 (at 60° C.); magnetic susceptibility, $+0.55\times10^{-6}$ (at 18° C.); melting point, 651° C.; resistivity, 4.35 microhms per cm^3 (at 0° C.); temperature resistance coefficient, 0.0038 (between 0° and 100° C.); thermoelectric power, +2.22 microvolts (at 0° C.).

Some work recently done by the Bureau of Standards, Department of Commerce, in the Washington laboratories, on a sample of magnesium casting (99.9 per cent purity) gave the following values of physical properties:[1] Density, 1.737 g/cm^3 at 20° C.; coefficient of expansion, 0.0000257 at 40° C.; average coefficient of expansion between 0° and 100° C., 0.0000259 per degree C.

Magnesium is readily malleable and ductile at about 400° C. but difficultly so when cold. Its tensile strength when cast is considerably higher than that of aluminum, with an elongation of about 9 per cent. The compressive strength is high, and both tensile and compressive strengths may be increased by alloying.

A mirror-like polish can be given to magnesium, but it becomes dull after a few weeks' exposure.

CHEMICAL PROPERTIES.

Magnesium in powdered form or in a thin ribbon is easily ignited and burns in the air, producing an intense white light rich in actinic rays—those rays that produce chemical reaction on the photographic plate. Magnesium powder is explosive under certain conditions.

Magnesium becomes coated with a thin film of oxide when exposed to moisture, but remains unoxidized in dry air. It is not attacked by pure cold water but is attacked to a slight extent by boiling water. In the presence of a small quantity of any chloride magnesium decomposes cold water. An experiment in the chemical laboratory of the United States Geological Survey by George Steiger and the writer demonstrated the following facts: No visible effect is apparent on magnesium ribbon after boiling it in water one hour, but chemical examination of the water shows that it contains magnesium. Dilute acids dissolve it with active ebullition, like that of calcium carbonate in hydrochloric acid. If a coil of magnesium is immersed in dilute sulphuric acid, there is free evolution of hydrogen, the metal is quickly covered with a white coating, and the ribbon is dissolved in two to three minutes. Strong sulphuric acid creates a moderately active ebullition and eats the ribbon through in about 15 minutes. A mixture of strong sulphuric and fuming nitric acids has very slight action on magnesium at ordinary temperatures.

Coils of magnesium ribbon were left in solution 24 hours, with the following result: A coil in strong sulphuric acid was eaten through and separated into several curled pieces. In a mixture of equal parts of strong sulphuric and nitric acids the magnesium was so strongly attacked that the coil had fallen to several pieces, all of which had a heavy white coat and had uncoiled. In a mixture of equal parts of strong sulphuric and fuming nitric acids the coil was slightly coated but apparently not otherwise attacked. Coils left in caustic alkali solution for 24 hours were not attacked, the metal remaining bright and unaltered.

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[1] Personal communication, Apr. 24, 1919.

Magnesium combines with sulphur, phosphorus, and arsenic, and it readily reduces silica and boric acid. At red heat it combines directly with nitrogen and decomposes sulphurous acid, oxides of carbon, and many hydrocarbons.

Magnesium is a stronger deoxidizing agent than any of the common metals and so reduces most oxides, liberating the corresponding metals or nonmetals.

USES.

Magnesium is used in three forms—as a silvery powder or gray granular substance, as narrow ribbon, and as round or square sticks. Its application in art, science, and manufacture is at present neither extensive nor varied, but there is reason to believe that new uses will be developed and the cost of production will be so much reduced that magnesium may soon have wider application.

POWDER.

After months of research a method of powdering magnesium was worked out in the United States in 1917, and powder is now produced in different sizes, even to pass a 200-mesh screen.

Magnesium is used in powdered form for flash lights in photography. This powder is reduced to such fineness that it will pass through 150 to 200 mesh screen. The claim is made that the best flash powders are of the 150-mesh size. Magnesium powder, even the very finest, does not burn fast unless it is given a rapid supply of air or oxygen. To get the instantaneous combustion required for flash-light photography magnesium powder is mixed with some material rich in oxygen, such as nitrates, chlorates, or sulphates. The value of magnesium in photography is due to the fact that the intense white light it produces is rich in actinic rays.

Magnesium as an explosive was mentioned in a recent article[1] as follows:

> Powdered magnesium is among the best of explosive agents and so of high military value. Its quickness of action in depriving nitrates, chlorates, manganates, sulphates, and peroxides of constituent parts of oxygen, with the accompanying extremely high temperatures instantly effective for expanding the volume of the released gases and other volatilized constituents, gives magnesium its military utility.

Magnesium in powdered form had a large use in 1918 for military purposes. Because of the brilliant white light emitted it was used in star shells and other pyrotechnics to illuminate battle fields at night; and in special shells in order to see the exact location of the explosion—in the daytime by the white cloud of magnesium oxide, and at night by the brilliant white light produced by the combustion. The powder used for these purposes is coarser than the flash-light powder and varies with the different specifications from 40 mesh to 120 mesh. For this use magnesium may be mixed with aluminum and barium. Magnesium was used also for loading tracer bullets, such as 30-caliber tracer ammunition for aircraft. Magnesium explosives were used in the construction of boosters for smoke gas and incendiary shells usually fired from 4-inch Stokes trench mortars. In some of the larger ordnance as much as 1 pound of metallic magnesium was used in one projectile to show the trajectory. Large quantities of magnesium powder were used in parachute shells by the United States Navy, and perhaps by others.

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[1] Waldo, Leonard, Development of the magnesium industry: Chem. and Met. Eng., vol. 19, No. 8, pp. 624-625, Oct. 15, 1918.

Coarse powdered magnesium is used in the chemical laboratory in qualitative tests for phosphorus, and material not so fine as flash-light powder is used in fireworks, because of the beautiful effect of the briliant white light and the clouds of white smoke it gives off. The quantity used for this purpose never was large and with the change in method of celebrating festal occasions is probably decreasing.

RIBBON.

Magnesium in ribbon form is used in small quantity in chemical laboratories in the determination of potash and in qualitative tests for phosphorus. Some chemists prefer ¼-inch lumps of magnesium cut from bars or rods because these will sink and remain at the bottom of a solution, causing the stream of nascent hydrogen to rise through the whole body of solution. Ribbon magnesium tends to rise with the hydrogen and act only on the upper part of the solution. There are other special uses of magnesium ribbon, as in photographic time lights and in the ignition of thermite mixtures. These uses consume only a small quantity of ribbon annually.

STICKS.

Magnesium in massive form, as sticks or rods, is used as a deoxidizing agent for other metals and as a constituent in alloys. It may be used also as a dehydrating agent and as an electrode in electrolysis. These uses of massive magnesium are described briefly in the following pages.

DEOXIDIZING AGENT.

A deoxidizing metal is one whose oxide is more stable or insoluble than that of the material to be deoxidized. The use of a metal for this purpose is called scavenging—that is, clearing up oxides of other metals and making denser and more homogeneous alloys. In alloying other metals various other substances, as silicon, phosphorus, manganese, and aluminum, are used to remove oxygen. The oxide of magnesium is more stable at high temperatures than any of these, and therefore metallic magnesium would seem to offer promising possibilities in this use, especially to replace aluminum as a deoxidizer of steel.

Magnesium in stick form may be used as a deoxidizer or scavenger in the foundry for aluminum, copper, brass, nickel, Monel metal, zinc, iron, and steel. A smaller quantity of magnesium than of the common deoxidizers may be used, and practically none of it will remain in the finished casting; most of any other deoxidizer used goes into the casting as an alloy. In some products, as a pure copper casting requiring high electric conductivity, contamination with the deoxidizer would be objectionable.

For deoxidizing aluminum castings, from 0.25 to 0.50 per cent of pure magnesium in stick form is used. Most of this magnesium will remain in the casting as an alloy (aluminum is the only metal with which this happens), but it produces desirable rather than objectionable qualities in the aluminum casting. The addition of the small quantity of magnesium makes the metal flow more easily and increases the strength of the casting.

Magnesium is used to deoxidize copper and brass, but even less is required than for aluminum, about 0.03 per cent being enough. A pound of magnesium will deoxidize from 1,200 to 3,000 pounds of copper. Scarcely a trace of magnesium remains in the casting, practically all of it being used up in deoxidizing the copper. It is said to be better practice to employ as a deoxidizer a copper-magnesium alloy containing 10 to 20 per cent of magnesium than to use pure magnesium in stick form.

An alloy of 20 per cent magnesium and 80 per cent copper made by the American Magnesium Corporation, Niagara Falls, N. Y., and shipped crushed in pieces 3 inches in diameter and smaller is prepared simply to facilitate the use of magnesium in the foundry. Magnesium alone is so very light that it floats and burns on the surface of molten copper and brass unless special precautions are taken to keep it submerged. Pure magnesium can be used if this precaution is taken. This alloy is recommended by its manufacturers for use as a deoxidizer and scavenger in copper, brass, bronze, and phosphor-bronze castings.

The use of magnesium as a scavenger for aluminum, copper, brass, nickel, Monel metal, german silver, iron, steel, and zinc is described in a brochure printed by the Shawingan Electro-Metals Co. (Ltd.), Montreal, Canada.

ALLOYS.

Magnesium alloys with many metals and is used in stick form for this purpose. The so-called magnalium alloys, which have been known for many years, contain from 85 to 98 per cent of aluminum, from 1 to 15 per cent of magnesium, and sometimes small quantities of other metals such as copper, nickel, silver, zinc, iron, tin, and lead. The hardness of these alloys increases with the proportion of magnesium, but an alloy containing more than 15 per cent of magnesium is so brittle that it is of little use.

Castings of these alloys may have a tensile strength of 20,000 to 25,000 pounds to the square inch, but rolled, hammered, or drawn shapes, especially drawn wires, are said to have shown a tensile strength of 70,000 pounds or more to the square inch.

It is claimed that all these alloys are easy to turn, thread, file, and polish, and that they are not so easily attacked by dilute acids as ordinary aluminum and keep their polish better in the atmosphere. The alloy magnalium is used in Europe for kitchen utensils, tableware, knives, forks, and spoons, in instruments for surgical, optical and chemical purposes, in telephone, telegraph, and wireless apparatus, in watch cases, and in heavier articles such as saddle skeletons and piano frames. The greater stiffness and elasticity of magnesium alloys and their retention of polish are suggested by some dealers as qualities which should give them preference over the ordinary aluminum-copper alloys for all these uses and also for vacuum cleaners, automobile parts, typewriter frames, and gasoline engines. A very promising application of aluminum-magnesium alloy is for hydraulie valves and fittings usually made of brass and bronze. As the cost of the brass or bronze in large hydraulic fittings is a considerable item, there is good reason for the use of an alloy containing 96 per cent of aluminum, 2 per cent of magnesium, and 2 per cent of copper, and costing only half as much as brass per unit volume.

The following statements as to the composition of certain aluminum magnesium alloys are taken mostly from a paper by Paul D. Mercia [1] which discusses the physical and chemical properties of several alloys.

Duralum. Aluminum, 79 per cent; magnesium, 11 per cent; copper, 10 per cent. The copper contains 0.5 per cent of phosphorus.

Duralumin. The composition of this alloy varies somewhat, the following range being used: Copper, 3.5 to 5.5 per cent; magnesium, 0.05 per cent; manganese, 0.5 to 0.8 per cent; the remainder being aluminum. The density of duralumin varies from 2.75 to 2.84; its melting point is about 650° C.

Magnalium "X." Copper, 1.76 per cent; nickel, 1.16 per cent; magnesium, 1.60 per cent; remainder aluminum. Used for castings.

Magnalium "Y." About the same composition as "X," except that the nickel is replaced by small quantities of tin and lead. Used for castings.

Magnalium "Z." Tin, 3.15 per cent; copper, 0.21 per cent; lead, 0.72 per cent; magnesium, 1.58 per cent; remainder aluminum. Used for rolling and drawing.

Magnalite. Copper, 2.5 per cent; zinc, 0.5 per cent; magnesium, 1.3 per cent; nickel, 1.5 per cent; aluminum, 93.4 per cent. Used for castings.

The following paragraph is from a brochure issued by the Shawingan Electro-Metals Co. (Ltd.), Montreal, Canada:

> Of still greater interest than the "magnalium" alloys are the magnesium-aluminum alloys with or without zinc and copper. While "magnalium," in which aluminum is the principal constituent, becomes useless on account of brittleness when the alloy contains less than 85 per cent aluminum, it is possible in alloys where magnesium is the main component to go down as low as 68 per cent magnesium and yet obtain a useful metal. In castings magnesium-aluminum-zinc alloys are much tougher and stronger than any of the "magnalium" alloys and can stand vibration and shock much better. When the magnesium content is at least 93 or 94 per cent, these alloys may, by heating to about 350° C., be hammered into any shape. They can then be rolled and drawn. At a still higher temperature (considerably above 400° C.) the alloy becomes brittle and must therefore be handled with care. The principal advantages these alloys have over "magnalium" are: 40 per cent lower specific gravity; much greater strength and toughness, especially in castings; the property of withstanding shock and vibration; and, perhaps most of all, the properties required in a good bearing metal.

Magnesium is reported to be a good bearing metal. Some of its alloys have wearing qualities equal if not superior to those of cast iron. Its hardness is somewhat greater than that of tin, and in heat conductivity it is exceeded only by silver, gold, and copper. When its specific gravity is taken into consideration, its price per unit of volume is now one-half that of tin.[2] The high heat conductivity of the magnesium alloys (10 per cent higher than that of aluminum and about 2.7 times higher than that of cast iron) makes this material suitable for use in bearings and for many other applications, as in gas-engine pistons and parts. It is reported that in a comparative test for bearing qualities the best cast iron wore down twice as much as the magnesium alloy in the same time and under the same load. An alloy of magnesium and aluminum containing the compound Mg_3Al_4 when polished has good reflecting power and is said to be suitable for large optical mirrors.

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[1] Aluminum and its light alloys: Chem. and Met. Eng., vol. 19, No. 8, pp. 635–640, Oct. 15, 1918.

[2] Magnesium: Chem. and Met. Eng., Sept. 25, 1918, p. 528.

Several United States patents have been issued for alloys of magnesium with other metals in varying proportions. An alloy consisting of 92 per cent magnesium and 8 per cent aluminum, which is covered by United States patent 965485 (1910), is reported to have a specific gravity of 1.75 and a strength equal to that of gun metal.

A magnesium-aluminum alloy was used by the United States Government in 1918 for castings for aircraft engines. A special use of this alloy was for pistons, but magnesium-aluminum alloy was used also in the form of fabricated sheet parts and tubing in place of parts of airplanes made of wood and steel. Magnesium alloy was used also in the manufacture of gas masks.

The use of magnesium as a substitute for tin in brass and bronze valve bodies is suggested.[1] The quantity of magnesium used ranges from 0.05 to 0.1 per cent, and it is effective in producing dense metal.

In consequence of the improvement in method of production, reduction in cost, and experience derived from the present demands, it is reasonable to assume that the near future will see a great development of the magnesium alloys.

OTHER USES.

Magnesium may be used in dehydrating oils. When introduced in the form of small sticks it decomposes the water at 35° C., giving off hydrogen and forming magnesium oxide (MgO), which separates out. This method has been used in Europe to free aniline from its small content (about 2 per cent) of water.

The use of magnesium has been suggested as a cathode in electrolysis where it is wished to prevent the reduction at the cathode in neutral or alkaline solutions that contain no ions of the heavy metals, and also in the electrolysis of alkali chlorides for hypochlorite. Magnesium anodes can be used in the contact process for producing galvanoplastic deposits of nickel and cobalt.

ACKNOWLEDGMENTS.

The writer is indebted for helpful suggestions in the preparation of this report to Mr. I. R. Edmands, president of the American Magnesium Corporation, Niagara Falls, N. Y.; to Mr. W. R. Seigle, president of the Norton Laboratories (Inc.), New York City; and to Dr. Leonard Waldo, consulting engineer, Plainfield, N. J..

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[1] Magnesium: Eng. and Min. Jour., Oct. 28, 1918, p. 733.

TIN.

By Adolph Knopf.

SUMMARY.

The metallic tin obtainable from concentrate produced in the United States in 1918 amounted to 69 short tons. As in the past, practically all this concentrate was won from gravels mined in Alaska.

The tin imported in 1918 as metal and metal in concentrate reached the record quantity of 82,854 short tons, an increase of nearly 5,000 tons over imports in 1917. The metal imported and entered for consumption was 71,254 short tons and the tin produced by the domestic smelters, almost wholly from Bolivian concentrates, was 10,284 tons. The total supply of new or primary tin available for consumption was therefore 81,538 tons.

The world's output of tin in 1918 was about 142,000 short tons. The tin available for consumption in the United States therefore amounted to 57 per cent of the world's output.

DOMESTIC PRODUCTION AND DEVELOPMENT.

GENERAL STATEMENT.

Of the 69 short tons of tin estimated as obtainable from concentrate produced in 1918 Alaska produced 68 tons; 1 ton was obtainable from small lots of concentrate produced in the Carolina tin belt and in the Black Hills of South Dakota.

The tin obtainable from concentrate ("ore") produced in the United States (including Alaska) from 1907 to 1918 is shown in the following table:

Tin produced in the United States from domestic ore, 1907–1918, in short tons.

1907	60	1911	70	1915	102
1908	30	1912	130	1916	140
1909	20	1913	50	1917	110
1910	40	1914	104	1918	69

ALASKA.

Alaska produced 104 short tons of concentrate in 1918, a decrease of 67 tons from 1917. The recoverable content of this concentrate is estimated to be 68 tons of tin. Most of the tin concentrate, as in previous years, was won in the York district, 100 miles northwest of

Nome. Instead of two dredges operating, as in earlier years, however, only one was at work, that of the American Tin Dredging Co., which produced 55 tons of concentrate averaging 69.76 per cent of tin. In the Hot Springs district 45 tons of concentrate was obtained by sluicing the tailings of the placer gold mines. Howell & Cleveland completed 6 miles of a 19-mile ditch that is being built to hydraulic the benches of Sullivan Creek for gold and cassiterite.

A new locality in Alaska to produce tin was the Ruby district, on the south side of the Yukon, below the Tanana, where 2 tons of cassiterite was saved as a by-product of placer gold mining. The gravel is reported to average half a pound of cassiterite to the cubic yard.

Some work was done on the Lost River tin lodes, 15 miles east of the York placer tin district, but no ore was mined.

The examination of placer concentrates by the Geological Survey has resulted in finding stream tin in concentrates from the Yentna gold placer district in such amount as to indicate that it possibly occurs in commercial quantity. Small quantities have also been found in concentrate from Boob Creek, in the Tolstoi district; from Willow Creek, near Nome; and from Riglagalik River, in the Kuskokwim delta. The discovery of stream tin has been reported from Moran Creek, a tributary of Melozi River, which enters the Yukon from the north. The gravel of this new find is reported to contain 2½ pounds of tin and 10 cents in gold to the cubic yard.

Alaska's total output of tin (as estimated from the output of concentrate) since 1902, when tin mining began, is 916 short tons, almost all of which has been won from placers.

SOUTH DAKOTA.

The main activity in tin mining in the Black Hills was at Hill City, Pennington County, S. Dak., where the American Tin & Tungsten Co. was developing the Cowboy and Mohawk veins. This company is the successor of the Hill City Tungsten Co., which had come to grief in 1916 after attempting to mine as tin ore the pegmatite dike carrying columbite near the mill east of Hill City. Early in 1917 the American Tin & Tungsten Co. began to work the Cowboy mine, but it stopped operations in April. The employees threatened to put a labor lien on the property, but matters were finally adjusted without recourse to this measure. After this suspension of operations the company was reorganized and work was resumed in June, 1918. Progress was hampered by the difficulty of obtaining coal and other supplies, owing to the war-time restrictions in force. At the time of the writer's visit at the end of August, 1918, the Cowboy mine had been unwatered to the 200-foot level, and later it was unwatered to the 300-foot level.

The country rock inclosing the Cowboy vein consists of biotite schist, whose foliation, which probably coincides with the bedding, strikes N. 30° E. and dips vertically. The schists carry numerous small pink garnets and in places large crystals of staurolite also. The vein trends at right angles to the strike of the schists and fills a fissure along which some displacement had occurred prior to the filling of the vein. This is best shown on the 100-foot level, where dissimilar rocks form the foot and hanging walls, being in places markedly banded on one wall and massive in the other.

A shoot of ore 50 feet long on the 100-foot level was stoped out to the surface by the American Tin & Tungsten Co. in 1916–17 and yielded, according to the report of the superintendent, 1,500 tons of ore, which was milled. On the 200-foot level the shoot is 77 feet long and ranges from 1.5 to 2.5 feet in thickness. A raise has been put up about 40 feet and a little stoping has been done. The 100-foot level has been driven on the vein 250 feet beyond the ore shoot, but the vein hardly averages more than 1 to 2 inches in thickness, though locally swelling to 8 inches, and it is barren of visible cassiterite. On the 200-foot level the vein pinches out, apparently completely, 50 feet southeast of the shaft. So far as developed at the time of the writer's visit the Cowboy vein was 300 feet long and contained an ore shoot 60 feet in length and about 1.5 feet in thickness.

Late in 1918 development work was done on the 300-foot level. According to the manager 2,500 tons of ore, averaging 1.98 per cent of tin, was mined in 1918.

The company did development work on the Mohawk vein also. The vein strikes parallel or nearly parallel to the strike of the inclosing schists but cuts across them on the dip. The footwall is well defined, at least in places, but the hanging wall is indefinite and consists of highly micaceous coarse greisen, which carries cassiterite, locally in considerable quantity. The vein in places consists largely of quartz, which is practically barren or carries a little cassiterite in the very rare nests of white mica embedded in the quartz. The quartz averages from 2 to 3 feet in thickness. At the time of the writer's visit a shaft, called the No. 1, had been sunk 37 feet on the vein, and from the bottom of it a drift had been run 35 feet north. North of these workings some work was done on what is probably a faulted segment of the same vein.

The old mill of the Harney Peak Tin Mining, Milling & Manufacturing Co., 1 mile east of Hill City, was put in working condition and the equipment altered both to reduce its capacity from 200 to 100 tons a day and to effect a saving of cassiterite that otherwise would be lost by sliming.

Mills Bros. report that they produced 400 pounds of concentrate carrying 60 per cent of tin, which was obtained from 4 tons of the ore mined while doing assessment work on the Tin Boom claim, half a mile west of Hill City.

NORTH CAROLINA AND SOUTH CAROLINA.

The North Carolina Tin Co., which was organized in 1918, carried on development work on the property of the United States Tin Co., near Lincolnton, N. C.

At the Cherokee mine (formerly the Ross), 1 mile north of Gaffney, S. C., 600 pounds of concentrate was obtained by treating the detrital material derived from a tin-bearing pegmatite dike. This hillside detritus is reported to carry 1 pound of tin to the cubic yard. The quantity of concentrate shipped was 200 pounds.

Some placer ground near Kings Mountain, N. C., was treated and is reported to have given favorable results.

WASHINGTON.

Development work was done on the tin-bearing pegmatite near Spokane, Wash., and 150 tons of ore carrying 8 per cent of tin is said to have been mined.

NEW MEXICO.

Some material sent to the Geological Survey from New Mexico for identification in August, 1918, proved to be wood tin, the peculiar variety of tin oxide distinguished by its concentric banding, which resembles the growth rings in wood. In May, 1919, the Survey was informed by the sender, C. J. Cromley, who had obtained the original material from a prospector, that he had succeeded in finding the source of the material on Taylor Creek at the head of the East Fork of Gila River. Apparently the wood tin occurs in the stream gravels for a distance of 1 or 2 miles. Much of it is intimately intergrown with iron-oxide minerals—hematite and a magnetic variety, possibly magnetite. A few of the nuggets have rhyolite adhering to them, which shows that they have been derived from stringers in rhyolite. Tridymite and opal occur also with the wood tin. The ore is very similar in appearance and mode of occurrence to the tin mineral found in many parts of Mexico and especially to that recently discovered in Nevada but nowhere else in the world. From what is known of the Mexican veins, it is unlikely that workable tin-bearing veins will be found in the rhyolite, though, of course, it is not impossible, as there are exceptions to all rules. The most practical thing for the prospector to do at present is to examine the placers thoroughly in order to determine the quantity of tin-bearing gravel available and the number of pounds of tin it carries to the cubic yard.

VIRGINIA.

The Martha Cash tin mine, in Rockbridge County, Va., was commandeered by the War Department, through the War Industries Board, acting under the broad war powers conferred on the President. The deposit has been considered to be one of the most promising in the United States, but has been idle since 1893, owing to the extraordinarily involved litigation in which the property has become entangled. After the property had been commandeered by the Government it was leased to private parties, who began to open up and prospect the different veins, but the results are reported not to have been encouraging. According to the Bureau of Mines,[1] "the ore bodies, so far, are disappointing, both as to size and metallic content. Of 19 samples taken, 14 gave blank returns, and the remaining 5 showed an average of less than 1.5 per cent tin." As a result, work was discontinued early in 1919.

NEVADA.

The Mason Valley Mines Co. continued to explore the tin and copper ore shoots at Majuba Hill, 25 miles west of Imlay, Humboldt County, Nev. The tin ore forms an isolated shoot along the fissure containing the shoot of copper ore, which is the chief object of the mining operations. The tin ore consists of an intimate intergrowth of tourmaline, quartz, and cassiterite and is inclosed in tourmalinized rhyolite breccia and rhyolite porphyry intrusive into slates, which are probably of Triassic age. The copper ore consists of chalcocite, cuprite, chrysocolla, arsenopyrite, tourmaline, and some fluorite. The primary (hypogene) copper-bearing mineral was probably in the main chalcopyrite, which occurs sporadically intergrown with tourmaline near the ore body.

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[1] Excerpt from monthly reports on minerals investigations in the Bureau of Mines, Dept. of the Interior, February, 1919.

No work was done during 1918 on the tin-bearing veins in the Tertiary rhyolites of northern Lander County.

SMELTING.

Four tin-smelting plants were in operation in the United States in 1918 and produced 10,284 short tons of tin. Practically the whole of the output was smelted from Bolivian concentrate. The largest output was made by the American Smelting & Refining Co., at its plant at Perth Amboy, N. J., which produced 9,934 tons of tin.[1] Part of its product is marketed as electrolytic tin assaying 99.9 per cent or more, and part as smelter tin assaying 99.3 per cent or more.

The Williams Harvey Corporation commenced smelting tin in November at its plant on Jamaica Bay, Brooklyn, N. Y.; and the Andes Electin Co., of New York City, and the Eastern Metal & Refining Co., of Boston, Mass., also produced some tin.

The following table shows the smelter output of tin in the United States since 1916, when the smelting of imported tin-bearing concentrate in this country was first begun.

Smelter output of tin in the United States, 1916–1918.

	Short tons.
1916	2,261
1917	6,065
1918	10,284

IMPORTS.

The total quantity of tin imported in 1918 was 82,854 short tons. This total is the sum of two quantities—71,254 tons of tin imported "in bars, blocks, pigs, or grain or granulated," and 11,600 tons estimated as obtainable from the 18,394 short tons of Bolivian concentrate containing 63 ± per cent of recoverable tin which was imported during the year. The imports came from the following countries, but the real origin of the tin is not wholly disclosed by this table:

Tin imported into the United States in 1918.

	Short tons.
Straits Settlements	36,067
Bolivia (tin in concentrate)	11,600
Dutch East Indies	10,670
England	9,038
Hongkong	7,890
Australia	3,787
China	1,603
Japan	1,203
British India	534
Chile	232
Canada	225
Other countries	5
	82,854

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[1] American Smelting & Refining Co. Twentieth Ann. Rept., 1918, p. 13, 1919.

Tin ore imported into the United States, 1916–1918.

Year.	Quantity (short tons).	Value.
1916	9,304	$4,036,821
1917	9,054	4,743,099
1918	18,394	11,444,401

Tin imported and entered for consumption in the United States, 1906–1918.[a]

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1906	50,476	$37,447,315	1913	52,329	$46,927,213
1907	41,257	32,074,263	1914	47,530	32,881,619
1908	41,267	23,923,560	1915	57,792	38,736,909
1909	47,662	27,558,546	1916	69,035	51,802,232
1910	52,528	33,913,255	1917	72,166	63,860,340
1911	53,527	43,346,394	1918	71,254	93,144,218
1912	58,016	50,372,478			

[a] Compiled from the records of the Bureau of Foreign and Domestic Commerce.

PRICES.

The average price of spot Straits tin in New York in 1918 was 86.8 cents a pound, as compared with 61.65 cents for 1917. The course of the market during the year is shown in the following table:

Average monthly prices, in cents per pound, of Straits tin in New York in 1918.[a]

Month.	Prompt.[b]	Futures.[c]	Month.	Prompt.[b]	Futures.[c]
January	84.00	70.00	July	98.00	85.00
February	85.00	72.00	August	90.00	80.00
March	87.00	76.00	September	80.00	73.00
April	90.00	83.00	October	80.00	[d] 72.50
May	105.00	93.00	November	74.00	[d] 72.50
June	97.00	82.00	December	71.50	[d] 72.50

[a] American Metal Market and Daily Iron and Steel Report, vol. 26, Feb. 5, 1919.

[b] Approximate averages based on sales of Straits and other grades of pure tin for prompt delivery, for the most part in small lots.

[c] Approximate averages based on sales of Straits tin for shipment from Singapore. The prices for Straits for many months were below those paid for Chinese and other grades on which the shipping restrictions were not so great.

[d] On October 3 all licenses to import tin, except to United States Steel Products Co., were refused on orders in accordance with interallied agreement. The price of 72½ cents represents the average cost to United States Steel Products Co. of tin imported by it under this agreement.

The average price for the year in London was £329 11s. per ton of 2,240 pounds. The lowest price was £236 and the highest price was £399.[1] The average price for 1918 was far above any previous record, but this increase in the price of tin over pre-war prices was relatively smaller than that of copper and other common industrial metals.

WORLD'S OUTPUT.

The world's output of tin in 1918 is estimated to be 129,000 metric tons, a decrease from that of 1917. The output in the various tin-producing countries from 1913 to 1918 is shown in the accompanying table. The figures given are based on official reports and as far as possible are those of mine output, but for some countries, such as Bolivia, China, Siam, and Nigeria, the figures represent exports. Where the output is given in the original sources in terms of tin-bearing concentrate—as, for example, it is for the Australian States—it is here given in terms of metal obtainable by smelting. It is highly desirable in the interest of accuracy that the mineral statisticians of each tin-producing country report the output in terms of metallic tin.

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[1] Metal Statistics, 1919, p. 272.

World's output of metallic tin, 1913–1918, in metric tons.

[Metal obtainable by smelting from concentrates.]

Country.	1913	1914	1915	1916	1917	1918
Federated Malay States	50,930	49,820	47,520	44,570	40,470	37,970
British Protected Malay States	1,800	2,700	4,170	4,450	4,500	4,500
Bolivia	26,760	22,360	21,900	21,330	28,320	29,770
Banca	15,940	14,630	13,660	14,460	13,540	11,000
Billiton and Singkep	5,300	6,090	6,760	6,780	7,300	9,200
China	8,390	7,120	8,000	7,630	11,800	8,500
Siam	6,660	6,740	8,520	8,960	8,600	8,600
Nigeria	2,950	4,590	4,630	5,150	7,070	7,000
Australia	8,160	5,520	5,680	5,550	4,970	4,900
Cornwall	5,370	5,140	5,060	4,770	4,000	4,000
Union of South Africa	2,050	2,000	2,050	1,900	1,540	1,370
Other countries	1,400	1,500	1,500	1,700	1,800	2,000
	135,710	128,210	129,450	127,250	133,910	128,810

PUBLICATIONS.

The following list includes the more recent publications relating to tin deposits in the United States. The Survey publications, except those to which a price is affixed, may be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications may be purchased from the Superintendent of Documents, Washington, D. C. Those marked "Exhausted" and the other publications can be consulted at the large public or university libraries of the country.

GENERAL.

Hess, F. L. and Eva, Bibliography of the geology and mineralogy of tin: Smithsonian Misc. Coll., vol. 58, No. 2, 408 pp., 1912.

Is an exhaustive bibliography of the geology, mineralogy, mining, milling, metallurgy, history, and statistics of tin.

Hess, F. L., and **Graton, L. C.**, The occurrence and distribution of tin: U. S. Geol. Survey Bull. 260, pp. 161–187, 1905. Exhausted.

Is a concise account of the geologic occurrence and distribution of tin deposits throughout the world.

Knopf, Adolph, Tin in 1917: U. S. Geol. Survey Mineral Resources, 1917, pt. 1, pp. 63–72, 1918.

Includes a map showing the geographic distribution of the world's output of tin in 1916.

ALASKA.

Eakin, H. M., A geologic reconnaissance of a part of the Rampart quadrangle, Alaska: U. S. Geol. Survey Bull 535, pp. 37–38, 1913. 20c.

Cassiterite occurs in gold placers and is saved as a by-product during the mining of the gold.

——— Tin mining in Alaska: U. S. Geol. Survey Bull 622, pp. 81–94, 1915. 30c.

A concise but full description of the geology of the Alaskan tin deposits, both lode and placer, and of the condition of the tin-mining industry.

Johnson, B. L., Occurrence of wolframite and cassiterite in the gold placers of Deadwood Creek, Birch Creek district, Alaska: U. S. Geol. Survey Bull. 442, pp. 246–250, 1910. 40c.

The gold-bearing gravels average 1 to 2 pounds of concentrate (chiefly wolframite and cassiterite, with some magnetite and garnet).

Knopf, Adolph, Geology of the Seward Peninsula tin deposits: U. S. Geol. Survey Bull. 358, 72 pp., 1908. 15c.

The geology and tin deposits of the York district and of Ear Mountain, both in the western part of Seward Peninsula, Alaska, are described in detail.

CALIFORNIA.

Fairbanks, H. W., The tin deposits at Temescal, southern California: Am. Jour. Sci., 4th ser., vol. 4, pp. 39–42, 1897.

The tin deposits are at Cajalco Hill, near Corona, Riverside County, in southern California. The ore occurs in irregular shoots in quartz-tourmaline veins inclosed in granite. The principal vein was opened to a depth of 180 feet by two shafts 300 feet apart. The ore milled averaged 5 per cent of cassiterite.

Ingalls, W. R., Mineral Industry, vol. 5, p. 587, 1897.

Describes briefly the metallurgical operations at the Temescal or Cajalco Hill tin mine, in southern California. The concentrate, which averaged 65 per cent of tin, was smelted in a Cornish reverberatory furnace, California oil being used for fuel and New Mexico coal for reducing agent. The tin smelted was of good quality, and 135 tons were produced before the mine shut down [in September, 1892].

Schaller, W. T., Cassiterite in San Diego County, Calif.: U. S. Geol. Survey Bull. 620, pp. 351–354, 1916. 30c.

A pocket of cassiterite crystals was found in a pegmatite dike.

IDAHO.

Bell, R. N., Tin in Idaho: Mining industry of Idaho, Twentieth Ann. Rept., 1918, p. 104, 1919.

The gravel of Panther Creek contains gold and stream tin, and the conditions are favorable for hydraulic operations.

Umpleby, J. B., Geology and ore deposits of Lemhi County, Idaho: U. S. Geol. Survey Bull. 528, pp. 74, 76, 1913. 40c.

Some stream tin [of the variety known as wood tin] has been found in the gravels of Silver and Panther creeks.

NEVADA.

Knopf, Adolph, Tin ore in northern Lander County, Nev.: U. S. Geol. Survey Bull. 640, pp. 125–138, 1916. 30c.

The recently discovered lode and alluvial tin deposits are described. The lode tin ore consists of wood tin associated with specular hematite, chalcedony, lussatite, tridymite, and opal. The veins occur in rhyolite flows of middle Tertiary age.

NORTH CAROLINA AND SOUTH CAROLINA.

Graton, L. C., Reconnaissance of some gold and tin deposits in the southern Appalachians: U. S. Geol. Survey Bull. 293, 134 pp., 1906. 15c.

The tin ore of the Carolinas occurs as an original constituent of pegmatite dikes. Detailed descriptions of the deposits are given.

Keith, Arthur, and **Sterrett**, D. B., Tin resources of the Kings Mountain district, North Carolina and South Carolina: U. S. Geol. Survey Bull. 660, pp. 123–146, 1917 (Bull. 660–D).

Describes the geology of the Carolina tin belt and the tin deposits, except some near Lincolnton, N. C. The development work done to date is described.

SOUTH DAKOTA.

Darton, N. H., U. S. Geol. Survey Geol. Atlas, Sundance folio (No. 127), 12 pp., 1905. Exhausted.

Gives a geologic map and structure sections of the Tinton (Nigger Hill) tin-bearing area of the northern Black Hills. The deposits are briefly described.

Hess, F. L., Tin, tungsten, and tantalum deposits of South Dakota: U. S. Geol. Survey Bull. 380, pp. 131-163 (tin, pp. 134-149), 1909. 40c.

Describes the tin deposits of the Black Hills. The ore occurs in small shoots in pegmatite dikes and quartz veins.

TEXAS.

Richardson, G. B., Tin in the Franklin Mountains, Tex.: U. S. Geol. Survey Bull. 285, pp. 146-149, 1906. Exhausted.

——— U. S. Geol. Survey Geol. Atlas, El Paso folio (No. 166), pp. 9-10, 1909. To be obtained from the Geological Survey for 5c.

Narrow quartz veins carrying cassiterite traverse post-Carboniferous granite.

VIRGINIA.

Ferguson, H. G., Tin deposits near Irish Creek, Va.: Virginia Geol. Survey Bull. 15-A, pp. 1-19, 1918.

The tin ore occurs in quartz veins, which are inclosed in a granite of a peculiar type, a hypersthene granodiorite. The ore probably forms shoots of variable size and content of tin, but the present condition of the workings and the extent of the developments are such as not to afford conclusive evidence on these features. The deposits are considered promising and to merit new exploration.

WASHINGTON.

Collier, A. J., Tin ore at Spokane, Wash.: U. S. Geol. Survey Bull. 340, pp. 295-305, 1908. 30c.

The tin ore is cassiterite, which is apparently an original constituent of pegmatite. About 125 tons, containing 4 per cent of metallic tin, was extracted.

ANTIMONY.[1]

By HENRY G. FERGUSON.

THE ANTIMONY SITUATION.

The United States is dependent upon three classes of material as sources of antimony or its alloys or compounds. (1) Antimony ore is imported from China (direct or via Japan), Bolivia (via Chile and Peru), and Mexico, and small quantities of ore are produced in the western United States. (2) Liquated antimony sulphide, also known as "crude antimony," "needle antimony," and antimony matte, is imported in small quantity from China. This material is produced by submitting the ores of the natural antimony sulphide, stibnite, to a red heat sufficient to melt but not to decompose it, and the metallic sulphide is then run into molds and allowed to cool. (3) Metallic antimony, known as antimony regulus, is imported from China, Japan, and Mexico, and during the war was produced in small quantity in the United States from both foreign and domestic ores. The metallic antimony imported from Japan is derived mainly from the refining of Chinese ore or "crude." A fourth class of material which should also be mentioned is antimonial lead, carrying from 12 to 18 per cent of antimony. Any of the three classes of materials noted above may enter into this product, but it is derived mainly from lead ores, most of them of the antimonial variety.

The United States has always been dependent mainly on foreign sources for its supplies of antimony. China and Japan have been the principal contributors, although Mexico and Bolivia have also made considerable contributions. This dependence is a reflection of the higher wage scale in this country as compared with certain foreign countries, particularly China, but it is due also to our comparative poverty in antimony resources, although little information of a quantitative nature has been collected concerning these resources, and they may be greater than has generally been assumed.

For many years prior to the European war the New York prices of the ordinary grades of metallic antimony ranged from 6 to 8 cents a pound; the imports, calculated as antimony metal, ranged from about 4,000 to 7,500 short tons; and the production from ores mined in this country was negligible. With the outbreak of the war the price of antimony began to rise rapidly because of the need of the metal in the manufacture of shrapnel bullets, and as uncertainty was felt as to the continuance of supplies from abroad, numerous mines in the Western States and several in Alaska were put into operation. By the end of 1915 the New York price had reached 40 cents a pound, and by March, 1916, it attained its maximum, for ordinary grades, of about 44 cents. These high prices drew out in the United States in 1915 a production of ore carrying about 2,100 short tons of antimony, and in 1916 ore containing about 1,770 short tons of antimony. The high prices also greatly stimulated imports, as is shown in Plate I, and this forced down the prices of ordinary grades to 11 or 12 cents late in 1916 and made it impossible for most of the new domestic mines to operate at a profit. By the end of 1916 many of these mines had closed and others were in a precarious condition.

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[1] Much of the material relating to trade conditions in the United States during the war is derived from "Antimony in 1917", by E. S. Bastin (Mineral Resources, 1917, pt. 1, pp. 653-663, 1919). In the preparation of data relating to foreign countries the writer had the assistance of L. M. Prindle, of the United States Geological Survey, and D. A. Hall, of the United States Shipping Board.

In anticipation of the entrance of the United States into the war there was a notable recovery in prices, ordinary grades reaching about 33 cents in April, 1917. This increase again stimulated imports (see Pl. I), which proved to be far in excess of the demands and not only forced a rapid decline in price to a fairly constant level of about 14 cents during the last half of 1917, but also built up large stocks in bonded warehouses (see fig. 2) and in the hands of dealers and consumers. Stocks in bonded warehouses alone, which were negligible in 1917, amounted to more than 10,000,000 pounds at the end of the year. The decline in prices in 1917 dealt a heavy blow to domestic antimony mining, which during the year produced ore carrying only about 390 short tons of metallic antimony. Before the end of the year nearly all domestic mines had ceased operation.

In 1918 the prices of antimony did not show the extreme fluctuations of the three preceding years. At the beginning of the year very large stocks were on hand and as these were absorbed imports increased. In January the price was slightly over 14 cents a pound; this decreased gradually to about 12 cents in May and then rose to 14 cents a pound in September. As antimony is used in large quantities for war purposes, the armistice brought a sharp drop in price. For the week ending October 26 the average price quoted by the Engineering and Mining Journal was 13 to 13½ cents a pound. The following week brought increased probability of cessation of hostilities, and prices fell off about 1 cent. On November 9 the price quoted was 10 to 11 cents, and on November 16, 9 cents. Prices fell to about 7 cents a pound at the end of the year, and approximately that price has been maintained during the first five months of 1919. At the end of 1918 stocks in bonded warehouse amounted to about 5,000,000 pounds, or about half what they were at the beginning of the year.

Domestic producers could not make a profit at the prices prevailing in 1918 and only about 190 tons of ore, containing about 50 tons of antimony, was mined. The antimony smelters continued production from imported ores until November, when all production of metallic antimony was temporarily suspended.

Most of the producers of antimony ore report that a price of 20 to 25 cents a pound for metal would be required to give ore prices sufficient to make the mining of domestic antimony ore profitable at the costs prevailing in 1918. It is probable, however, that antimony mining could be undertaken if there was assurance that a price of 16 or 17 cents would be continued over a considerable period, and according to one operator assurance of a steady price of 11 or 12 cents a pound would encourage production.

There is no reason to expect that prices of antimony will increase greatly during 1919, unless there should be a greatly increased tariff on antimony and antimony ores, as a surplus of antimony seems to be the condition over the entire world.

The sudden ending of hostilities found the belligerents with large stocks of antimony on hand. The only figures as to stocks so far published are those of the British Ministry of Munitions, which on March 1, 1919, showed stocks of 4,325 long tons of antimony metal. There is reason to believe that the other Allies have stocks of the same order of magnitude, and if so there must be about a year's supply available at the present time, as the consumption of antimony in 1913 amounted to only about 20,000 tons. In addition to these stocks there are large supplies of antimonial lead and other alloys available, and more will undoubtedly be obtained by salvage operations. It may be expected, therefore, that until these supplies are absorbed, the production of antimony will be even less than that of pre-war years. At present there is little inducement for mining. The price of antimony in May, 1919, was lower than in 1913, but costs of mining have increased everywhere. China, the largest producer, faces a particularly difficult situation, as the increased price of silver has resulted in doubled costs of labor and local supplies. If silver prices remain high after the demand for primary antimony has recovered, the other antimony-producing countries which are not on a silver basis will have a corresponding advantage over China in the matter of production.

It is likely that antimony mining will be of little importance in 1919, but it may begin to return to pre-war figures by 1920. The price, now abnormally low on account of the large accumulated stocks, will probably increase to a figure above the average for 1913.

The American market was largely controlled from London prior to the war, but now that Chinese and Japanese brands have become so firmly established, our market is hardly likely to return to the dominance of British firms.

USES.

Metallic antimony unalloyed has few industrial uses. In the form of fine powder, known as "iron black," it is used for producing the appearance of polished steel on articles made of papier-mâché or pottery. For these purposes it is precipitated by the action of metallic zinc on an acid solution of antimony salts. Antimony alloys readily with most heavy metals, and the alloy is harder than the two pure metals. Most of these alloys possess the property of slight expansion on solidifying. Type metal is an alloy of antimony, lead, and tin; babbitt, antifriction, or bearing metal is usually an alloy of antimony, tin, and copper. Britannia metal, also known as "white metal," is an alloy of antimony, tin, and copper, with some zinc and, rarely, small quantities of other metals. It is used in making cheap domestic tableware, teapots, and spoons. Antimony alloys find minor utilization in battery plates, toys, cable coverings, and siphon tops. Small quantities of antimony enter into certain brasses and aluminum alloys. Lead-antimony alloy, or "hard lead," is used in making acid-resisting valves.

White antimony oxide, mainly the tetraoxide (Sb_2O_4), is used for making opaque white enamel and other sanitary ware. In this use antimony oxides compete with tin oxide. Antimony oxide, mainly trioxide, is used as a coloring agent in the manufacture of glass, as it is more readily fusible than tetraoxide and does not impart opacity to the glass. Antimony oxides are also used as paint pigments.

The red sulphides of antimony are used in vulcanizing and coloring red rubber and also as paint pigments. The natural antimony trisulphide, stibnite, enters into the composition of safety matches or of the compound which is put on the match box.

Antimonate of lead, containing an excess of lead oxide, known as "Naples yellow," is used in oil paints and in the glass and ceramic industries. Tartar emetic (double tartrate of antimony and potassium) and antimony fluoride are employed as mordants in dyeing. Tartar emetic and antimony trioxide are employed medicinally.

Antimonial lead carrying 12 to 13 per cent of antimony is employed in the manufacture of bullets. Antimony sulphide is almost universally used as a constituent of primers in shells and cartridges.

Antimony sulphide as a powder is used in the charges of some shells to produce on explosion a dense white smoke, which is of service in range finding.

DOMESTIC PRODUCTION.

Antimony ore produced in the United States, 1915–1918, in short tons.

Year.	Ore.	Metal content.
1915	5,000	2,100
1916	4,500	1,770
1917	1,060	390
1918	190	50

Metallic antimony produced at smelters in the United States, 1917 and 1918, in short tons.

Year.	From domestic ores.	From foreign ores.
1917	258	2,182
1918	127	2,490

SMELTER PRODUCTION OF ANTIMONIAL LEAD.

The production of antimonial lead from lead skimmings as a by-product of the lead-smelting industry is tabulated for recent years in the chapter dealing with lead from figures collected by C. E. Siebenthal, of the United States Geological Survey. In 1916, 1917, and 1918 this production was as follows:

By-product antimonial lead produced in the United States from both foreign and domestic ores, 1916–1918.

	Gross weight (short tons).	Antimony content (short tons).	Value of antimony content.[a]
1916	24,038	3,496	$1,775,968
1917	18,646	2,759	1,142,226
1918	18,570	2,566	646,632

[a] Calculated on basis of average yearly price of 25.4 cents a pound, or $508 a short ton, in 1916, of 20.7 cents a pound, or $414 a short ton, in 1917, and of 12.6 cents a pound, or $252 a short ton, in 1918, for ordinary grades in the New York market.

RECOVERY OF SECONDARY ANTIMONY.

During 1918 5,183 short tons of antimony in the form of alloys and 43 tons of metallic antimony was recovered from old alloys, scrap, and dross.

Antimony content of secondary alloys recovered from old alloys, scrap, and dross, 1913–1918.

Year.	Quantity (short tons).	Value.[a]
1913	2,705	$401,963
1914	2,646	444,844
1915	3,102	1,811,568
1916	4,480	2,270,016
1917	4,961	2,061,700
1918	5,226	1,317,000

[a] Values calculated at average yearly price for ordinary brands of antimony as published by the American Metal Market.

IMPORTS.

The accompanying statistics of imports are compiled from the records of the Bureau of Foreign and Domestic Commerce, United States Department of Commerce, long tons being recalculated to short tons. The imports are reported as (1) imports for consumption, including merchandise entered for immediate consumption or withdrawn from bonded warehouses for consumption, and (2) total imports. Only total imports are listed by countries of origin.

Total imports [a] of antimony into the United States in 1917 and 1918.

Country.	Antimony ore.			Antimony metal.[b]	
	Quantity (short tons).	Antimony content.		Quantity. (pounds).	Value.
		Quantity (pounds).	Value.		
1917.					
Canada	126	105,077	$15,762	190,000	$24,879
Newfoundland and Labrador	22	30,136	1,985		
Mexico	2,116	1,434,403	76,712	4,126,659	416,866
Argentina [c]	596	632,662	55,514		
Chile [c]	4,098	5,131,569	507,463		
Peru	44	27,570	8,636		
Colombia	2	2,356	255		
Honduras	3	4,785	1,563		
China	2,949	4,060,353	331,504	11,324,846	1,333,541
Hongkong [d]				859,835	101,568
Japan [d]				18,677,597	2,333,745
England				470,176	87,081
Portugal	302	390,282	27,870		
Portuguese Africa [e]	112	101,250	9,734		
	10,370	11,929,443	1,031,998	35,649,113	4,297,680
1918.					
Canada				231,990	22,856
Panama	1	711	128		
Mexico	1,623	1,203,257	80,540	5,958,689	560,872
Chile [c]	987	1,343,700	84,890		
Peru [c]	11	14,594	1,100		
China	112	156,800	9,480	14,271,511	1,354,360
Hongkong [d]				1,064,224	109,532
Japan [d]				6,221,904	616,643
	2,734	2,719,062	176,138	27,748,318	2,664,263

[a] Includes large quantities of antimony metal that went into bonded warehouse and that are not included in the table of imports for consumption.

[b] Includes small quantities of liquated antimony sulphide, known in the trade as "crude antimony," "antimony matte," or "needle antimony."

[c] Imports credited to Chile originated mainly in Bolivia; those credited to Argentina may also be from Bolivia.

[d] Nearly all the imports of antimony ore and metal from Hongkong and Japan are of Chinese origin. Some of the material credited to other countries is possibly also of Chinese origin, having been transshipped in a foreign port.

[e] Probably of Transvaal origin.

The total imports show a marked decrease in 1918 as compared with 1917. Imports of ore decreased to a quarter of the quantity imported in 1917, Mexico being the only important source of foreign ore. Imports of metal decreased about 20 per cent, owing to decreased shipments from Japan. Metal imports from Mexico increased slightly. As shown in Plate I, imports during the early part of the year were comparatively small, but increased in the summer, reaching a maximum in September, after which they fell off sharply.

Antimony imported and entered for consumption, 1913–1918.

Year.	Antimony ore.[a]			Liquidated antimony sulphide.[b]		Metallic antimony.[c]		Antimony oxides and other compounds.[d]	
	Quantity (short) tons).	Antimony content (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	2,860	2,007	$137,361	3	$419	6,240	$798,581	984	$117,169
1914	1,791	1,254	71,341	49	4,004	6,555	736,420	1,372	315,001
1915	2,494	1,544	332,125	....	....	7,354	2,660,830	423	132,193
1916	7,840	4,622	1,072,340	....	....	7,064	3,548,507	243	109,832
1917	10,083	5,832	1,006,884	796	128,660	11,286	2,829,159	10	5,368
1918	3,363	1,425	177,731	833	113,258	14,011	3,065,619	18	11,904

[a] Classified in tariff classification as "Antimony ore and stibnite containing antimony."
[b] Classified in tariff classification as "Antimony matte, containing not more than 10 per cent of lead."
[c] Classified in tariff classification as "Antimony regulus or metal."
[d] Classified in tariff classification as "Antimony, oxide, salts, and compounds of."

For years large quantities of antimonial lead were imported into the United States as type metal, for which it is largely used, but since 1911 these imports have declined. The following table is compiled from the records of the Bureau of Foreign and Domestic Commerce:

Type metal imported and entered for consumption, 1911–1918.

Year.	Type metal.		Assumed antimony content.	
	Quantity (short tons).	Value.	Quantity (short tons).	Percentage.
1911	4,195	$310,658	727	17.3
1912	291	18,668	52	17.2
1913	284	20,098	50	17.6
1914	755	45,373	94	12.4
1915	1,384	107,607	172	12.4
1916	581	83,816	119	20.5
1917	None.	....	None.	....
1918	276	35,938	19	7.1

The customs returns give only the lead content of imported type metal, and the figures given above are based on the assumption that the remainder is practically all antimony, but this assumption is wholly arbitrary, for imported type metal contains as much as 2 per cent of impurities, such as iron, arsenic, and copper. The antimony content is therefore probably too large by some quantity less than or approximately equal to 2 per cent of the total quantity of type metal, and the correct percentage is correspondingly lower.

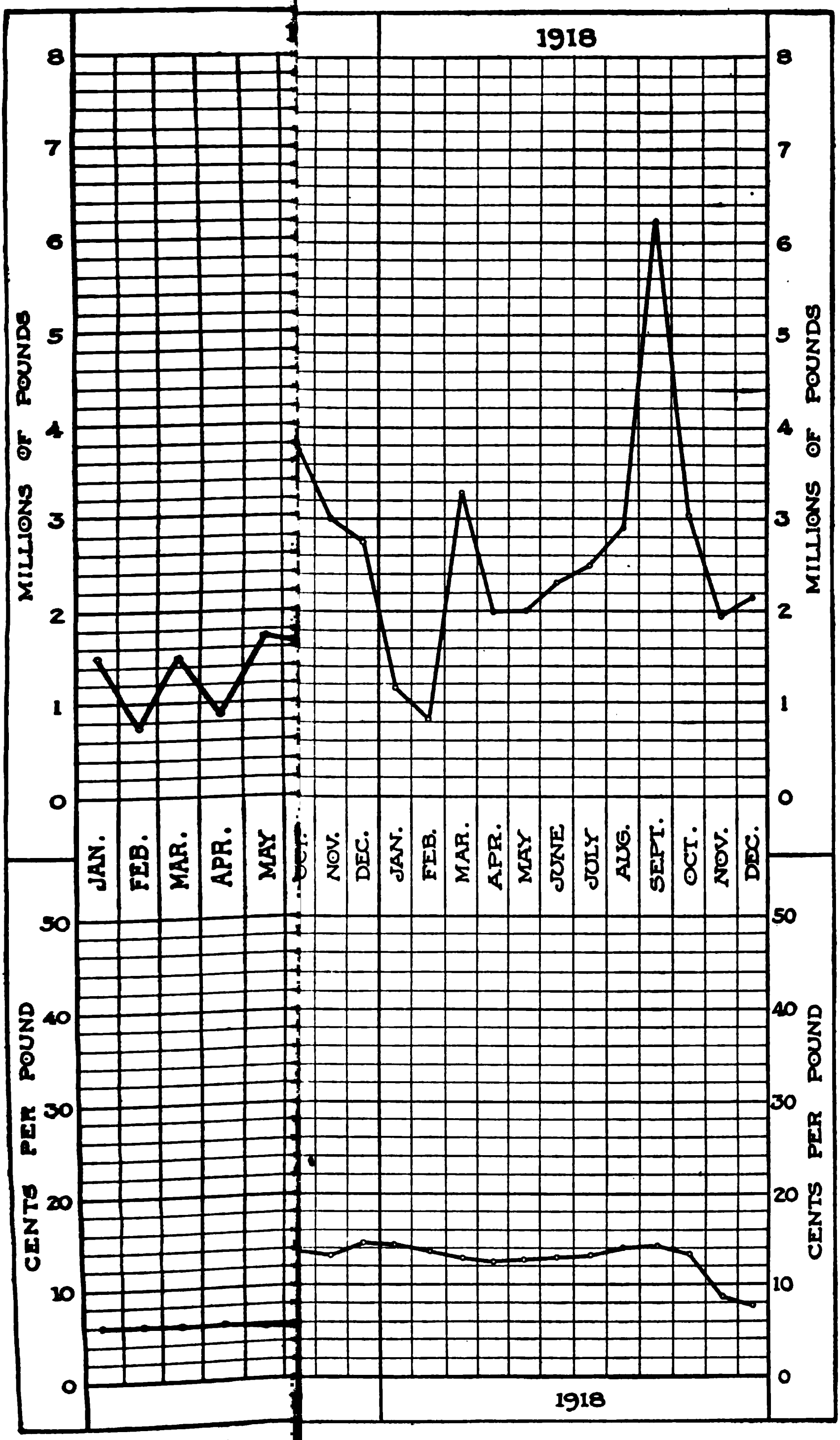

DIAGRAM SHOWING RY GRADES OF ANTIMONY METAL IN NEW YORK

EXPORTS.

Foreign antimony exported from the United States, 1914-1918.[a]

Year.	Ore.			Matte regulus, or metal.	
	Quantity (short tons).	Antimony content (pounds).	Value.	Quantity (pounds).	Value.
1914				1,600,979	$211,742
1915		195	$8	3,146,135	786,760
1916	231	255,695	9,874	3,018,251	761,045
1917				980,477	169,260
1918				1,410,970	164,666

[a] Exports go mainly to Canada.

STOCKS.

Large stocks had accumulated in bonded warehouses at the beginning of the year. The metallic antimony in bond December 31, 1917, as reported by the Bureau of Foreign and Domestic Commerce, was 10,401,682 pounds. An average of more than 10,000,000 pounds was maintained through March. Stocks then declined rapidly, and at the end of June were only about one-half of the quantity in bonded warehouse at the beginning of the year. No further figures are available until November 30, when less than 5,000,000 pounds was in storage. This quantity increased slightly during December, and at the end of the year stocks in bonded warehouse were slightly in excess of 5,000,000 pounds, or 2,500 short tons. The stocks of antimony held by dealers and manufacturers are not known and no figures have been published for the Government stocks, which must be disposed of, but it is reasonable to assume that the total supply of metallic antimony available at the beginning of the year equaled or exceeded a normal year's consumption for this country.

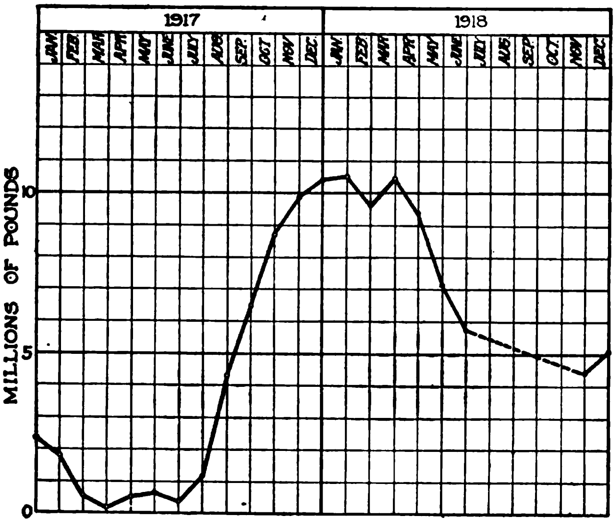

FIGURE 1.—Diagram showing stocks of metallic antimony in bonded warehouse at end of each month in 1917 and 1918, as reported by the Bureau of Foreign and Domestic Commerce.

PRICES.

The average New York prices for the highest grades of metallic antimony for the last 24 years, in cents per pound, are given by the Engineering and Mining Journal as follows:

1895	7.56	1903	6.00	1911	7.54
1896	6.65	1904	6.37	1912	7.76
1897	6.75	1905	10.25	1913	7.52
1898	8.69	1906	21.73	1914	8.76
1899	9.43	1907	14.84	1915	30.28
1900	9.50	1908	8.00	1916	25.37
1901	8.25	1909	7.47	1917	20.69
1902	6.12	1910	7.39	1918	12.58

The fluctuations in average monthly prices for the ordinary grades of metallic antimony during the five years 1914 to 1918 are shown in Plate I.

REVIEW BY STATES.

Alaska.—The following paragraphs are quoted from the report by Brooks[1] on the Alaskan antimony deposits:

> The antimony lodes thus far found and about which definite information is available occur in the Fairbanks, Kantishna, Innoko, Iditarod, and Port Wells districts and on the Kenai and Seward peninsulas. Lodes have also been reported, however, in the Nizina and upper Tanana districts. Further search is likely to reveal lodes in the regions where thus far stibnite has been found only as an accessory mineral.
>
> Stibnite has been found in only one vein in southeastern Alaska, and here it is only a sporadic occurrence as a minor accessory mineral. Southeastern Alaska is, therefore, not likely to yield any antimony ores. No stibnite occurs in the lodes of the Iliamna district, nor has it been reported in the gold ores of the Alaska Peninsula region. Fairbanks is the only mining district of the Yukon-Tanana region in which stibnite has been found.
>
> With the exceptions noted stibnite occurs in nearly all of the gold-bearing areas of Alaska.
>
> Most of the Alaska antimony deposits occur in auriferous quartz lodes. In these lodes stibnite is found with other ore minerals in different proportions, but only those in which it is the dominating sulphide offer any promise as a source of antimony. Another phase of the siliceous auriferous antimony lodes is furnished by the stibnite-cinnabar lodes. A more distinct type is formed by the replacement deposits in limestone, where the stibnite is associated with galena.
>
> The country rock of the stibnite lodes is sedimentary as a rule, but it differs greatly both as to age and lithology in the different districts. Some deposits have been found in highly metamorphosed schists of pre-Cambrian age. Others are found in little-altered clastics, as young as Upper Cretaceous. Practically all the antimony lodes occur in association with granular acidic intrusive rocks, among which the dominating lithologic types have been described as quartz diorite and monzonites. The formation of the stibnite lodes seems to have taken place principally in Tertiary time.

The production of antimony from Alaskan ores, which has declined rapidly since 1916 because of the low price of the metal, almost ceased in 1918, when only 36 tons of crude ore (stibnite), valued at $1,500 was mined. This includes the output of one mine in the Fairbanks district, some ore mined in the Broad Pass district but not shipped because of lack of facilities for transportation, and a small experimental shipment from near Nome. The shipments of ores of antimony from Alaska in 1918, according to the Bureau of Foreign and Domestic Commerce, contained 11,000 pounds of metallic antimony and were valued at $184.

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[1] Brooks, A. H., Antimony deposits of Alaska; U. S. Geol. Survey Bull. 649, pp 8-9, 1916.

Crude antimony ore produced in Alaska, 1915–1918.

Year.	Quantity (short tons).	Value.
1915	833	$74,000
1916	1,458	134,000
1917	165	28,000
1918	36	1,500
	2,492	237,500

Arkansas.—At the mine of the American Star Antimony Co. near Gillham, in Sevier County, Ark., some ore was mined in 1917, but not sold. Late in the year the plant was closed down, and no production was reported for 1918.

California.—No antimony ore was mined in California in 1918 although a small quantity of metallic antimony was produced by smelters from California ore shipped in 1917. Kern County was formerly the principal producing center, but there were mines and prospects in Calaveras, Inyo, San Benito, San Luis Obispo, and Tulare counties.

Idaho.—The antimony deposits of Idaho[1] occur in Valley and Shoshone counties.

The Valley County antimony deposits are about 4 miles south of Yellowpine post office and 60 miles by road from Cascades, a station on the Long Valley branch of the Oregon Short Line Railroad. The country rock is biotite granite, cut by pegmatite, aplite, and basic dikes. The stibnite occurs in quartz veins associated with the pegmatites. One of the veins is traceable for 4,000 feet and commonly shows from 6 to 18 inches of clean sulphide. At one point there is a lens of stibnite 30 feet long with a maximum width of 5 feet. The deposits have been developed by the Idaho Antimony Mining Co.

The antimony deposits of Shoshone County occur near Pine Creek, near Kingston station, between Harrison and Wallace, on the main line of the Oregon-Washington Railroad & Navigation Co.

The property of the Coeur d'Alene Antimony Co. has been worked intermittently for 20 years and has produced a total of 2,000 tons of ore containing about 125 tons of metallic antimony. The stibnite-bearing vein crosses a slate country rock in a northwesterly direction. During 1918 a modern concentrating plant was erected. The company mined some ore and produced a small quantity of concentrates, but owing to the low price prevailing none was shipped.

Undeveloped antimony deposits occur in Idaho, Blaine, and Custer counties.

Montana.—Some development work was done by Julian Strawn & Sons on an antimony depost at Silver Star, in Madison County, Mont., but the prevailing prices in 1918 did not permit shipments.

Nevada.—In 1917 Nevada produced 870 tons of antimony ore. In 1918, however, production practically ceased. Only about 95 tons was mined and only a portion of this was shipped. The production came from deposits in Lander and Humboldt counties.

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[1] Thomson, F. A., Notes on the antimony deposits (of Idaho): Idaho Univ. School Mines, vol. 14, Bull. 2, pp. 49-53, 1919.

Antimonial silver-lead deposits have been mined in the Arabia district, Humboldt County.[1] The ore consists almost wholly of bindheimite, the so-called hydrous antimonate of lead. The ore bodies are fissure veins in granodiorite and the surrounding hornfels. The veins in the granodiorite have well-defined wells, but within a short distance after entering the hornfels they fray out into narrow stringers. The ore formerly mined in the Montezuma mine, which has been the chief producer, contained about 50 per cent of lead and antimony and 80 ounces of silver to the ton. Ore left in the stopes of other mines contains about 10 per cent of lead, 10 per cent of antimony, and 15 ounces of silver and 0.10 ounce of gold to the ton.

Washington.—The following statement concerning antimony in Washington is quoted from Jenkins:[2]

> Antimony has actually been mined at two places in Okanogan County, in north central Washington. One of these is 7 miles north and a little west of Tonasket, and is known as the Lucky Knock mine. The other is situated on Gold Creek, not far from Methow, in the southwestern part of the county. Here several deposits are situated in the same neighborhood. Chief among the claims on these deposits are the Dixie Queen and the Minnie, which have previously been mined and the product converted, in part, into white oxide before shipment.
>
> At the Lucky Knock mine, stibnite occurs in irregular pockety masses in limestones and calcareous shales. Some of the limestone beds are entirely white, others are bluish gray, and still others are black, more shaley, and with coal-like material between the layers. The deposit as a whole appears to lie along a locally disturbed, crushed, and possibly faulted area. The stibnite evidently is a replacement in the limestone. Near the surface the sulphide is oxidized to a heavy, earthy rock. Several hundred feet of tunneling has been done, and the ore shipped, amounting to a carload or so, is said to have been used mostly for experimental purposes in connection with the manufacture of enamel in the bath-tub industry, the work having been carried on by the Standard Sanitary Manufacturing Co., of Pittsburgh.
>
> On Gold Creek, 25 miles by road from Pateros, the nearest railroad station, is a group of claims controlled largely by the Gold Creek Antimony Mines & Smelting Co. It is said that a thousand tons of ore was shipped during 1915 and 1916, and also several hundred tons of the oxide, which was made near the mine. The ore is mostly stibnite, occurring in metamorphic sedimentary formations, largely slaty shales, sandy shales, and calcareous rocks. The ore bodies are irregular, pockety, or lenticular in form. In places, oxides of antimony occur near the surface. These are obviously of several varieties, and are yellow, red, and white. They occur only as surface oxidized portions of the sulphide bodies.

WORLD'S PRODUCTION.

As the United States is almost completely dependent on foreign sources for its supply of antimony, a rather detailed review of conditions affecting production in foreign countries is given in the following pages. The diagram on page 43 gives the world's production of antimony in terms of estimated recoverable content of the ore produced. The figures are only approximately accurate, as reliable statistics are not available for two of the largest producers, China and Mexico. For these countries it has been necessary to use the export figures for metal plus an estimate for the recoverable antimony in the ore and crude exported.

From 1897 to 1902 the world's antimony production averaged about 7,000 tons a year. The demand caused by the Russian-

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[1] Knopf, Adolph, The antimonial silver-lead veins of the Arabia district, Nev.: Bull. U. S. Geol. Survey 660, pp. 249–255, 1918.

[2] Jenkins, O. P., Antimony in Okanogan County, Wash.: Eng. and Min. Jour., vol. 106, p. 309, 1918.

Japanese war caused a temporary increase in production. The sharp rise in price in 1905 and 1906, apparently due to speculation and based in part on the fear that the Chinese deposits were becoming exhausted, brought the annual production up to about 15,000 tons. This rate continued after the fall in price in 1907 and 1908 and was maintained until about 1912, when there was an increase due principally to increased production in China, to over 20,000 tons. The rise in prices in the second half of 1914, consequent on the war demand, started a tremendous increase in production, which reached its maximum in an estimated world production of nearly 80,000 tons in 1916. The demand for war uses had been met, and the falling prices in 1916 and 1917 were reflected in the decreased production in 1917.

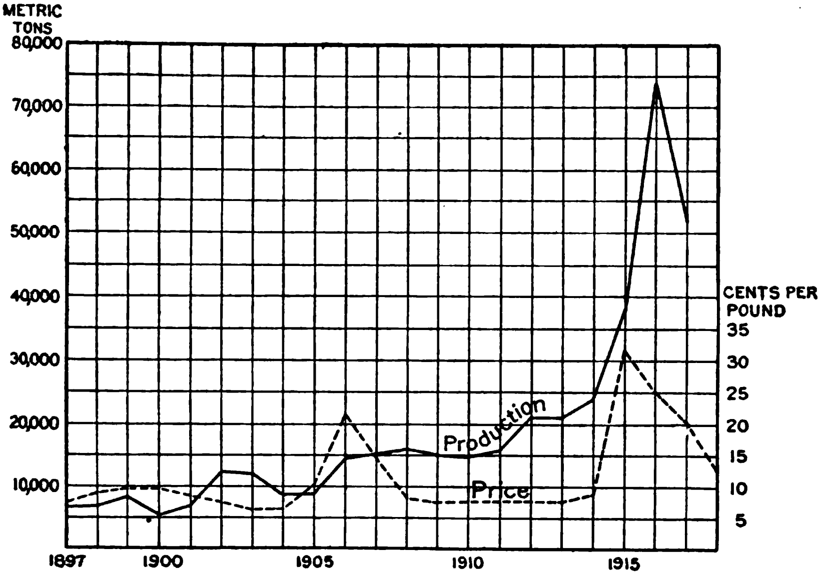


FIGURE 2.—Diagram showing world's production of antimony, based on estimated recoverable content of antimony ore, and average price per pound in New York.

Because of the various and not strictly comparable terms in which production is reported in most foreign countries, it is impossible to give more than a rough comparison between the principal important producers. As nearly as can be estimated the production of antimony ore in 1913, the last year for which even approximately complete statistics are available, amounted to about 21,000 metric tons of recoverable antimony, exclusive of the antimonial content of antimonial lead ores. The consumption is even more difficult to estimate, as customs figures for different countries are widely at variance. The relative importance of the principal producing and consuming countries in terms of percentages of the world's normal output for 1913 is about as follows:

Percentages of the world's production and consumption of antimony in 1913, by countries.

Country.	Percentage of production.	Percentage of consumption.
Austria-Hungary	4	4
France	24	20
Germany		20
Italy	2	2
United Kingdom		12
Serbia	1	
Asia Minor	1	
Japan		10
China	51	
Algiers	1	
United States		32
Mexico	11	
Australia (Victoria)	4	Small.
All others	1	
	100	100

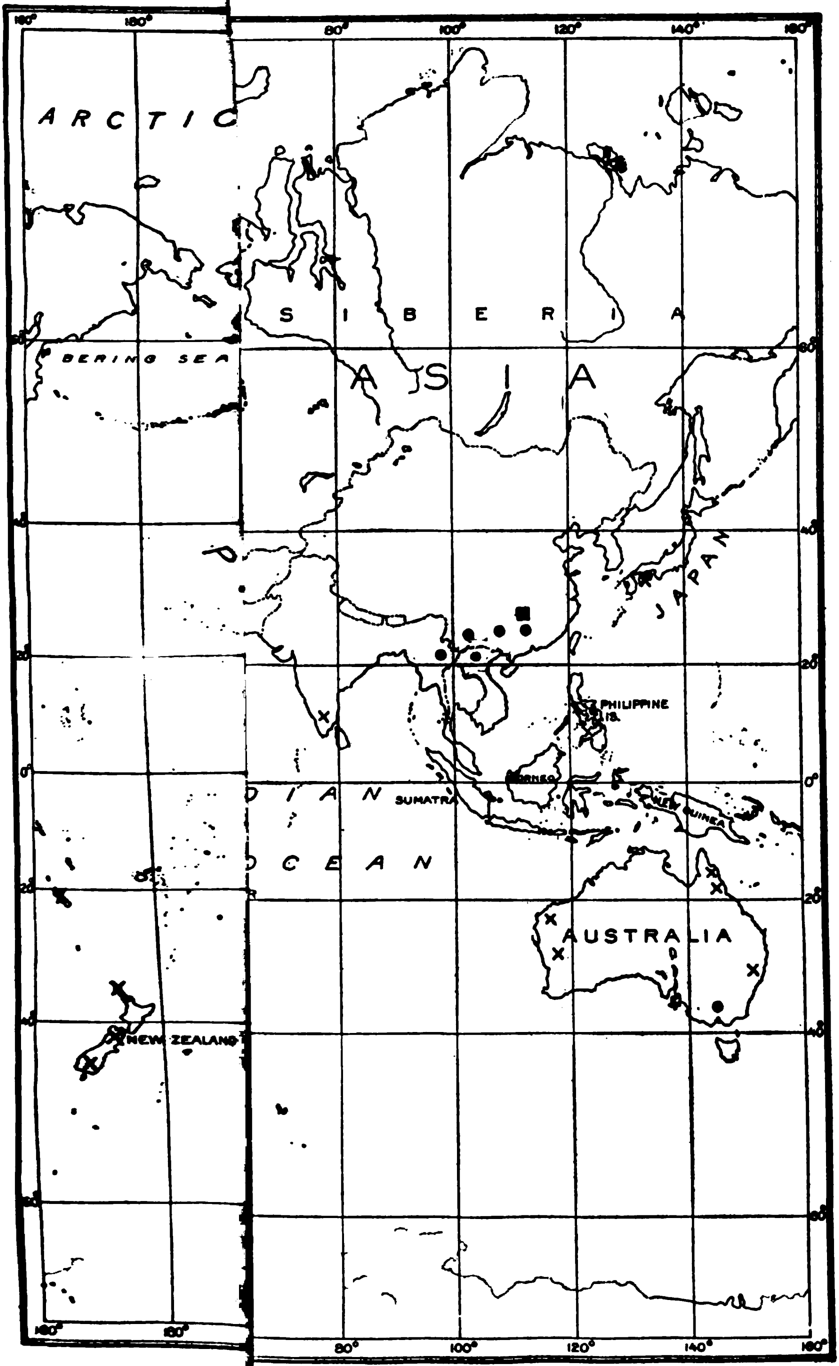
The following table shows the world's production for the years 1913–1917 so far as reasonably approximate data are available. An attempt has been made to reduce all statistics of production to a common basis—that of the recoverable metal content of the ore produced. The totals do not imply that this quantity of metallic antimony was actually produced. A part of the ore goes directly into the manufacture of oxides and other salts and in recent years lead smelters have purchased antimony ore which is smelted with lead ore for the direct production of antimonial lead. On the other hand, a small quantity of antimony is produced by lead refineries, and the antimony content of antimonial lead ores is not included in the table because sufficient data are not available.

World's production of antimony, 1912–1917, in metric tons.

[Approximate recoverable metal content of ore produced; antimonial lead ores not included.]

Country.	1912	1913	1914	1915	1916	1917
United States				1,760	1,420	310
Canada				420	300	120
Mexico	3,500	2,340	1,570	[b] 200	[b] 450	2,730
Bolivia	40	30	70	7,170	9,100	7,340
Peru				260	930	450
Austria-Hungary	1,350	840	(a)	(a)	(a)	(a)
Germany			(a)	[b] 700	(a)	(a)
France	2,290	5,170	(a)	(a)	(a)	(a)
Italy	310	360	110	720	1,080	960
Spain	170			100	170	160
Portugal	40	10	(a)	(a)	[b] 1,000	(a)
Serbia	300	[b] 250	(a)	(a)	(a)	(a)
Algiers	940	180	320	2,740	8,940	(a)
British South Africa		30		50	380	300
China	10,800	11,000	15,900	10,500	42,800	31,000
Japan	70	20	30	180	280	(a)
India					400	50
Indo-China	110			160	510	(a)
Borneo			300	120	(a)	(a)
Asia Minor	270	240	(a)	(a)	(a)	(a)
Victoria	580	960	890	1,300	1,320	(a)
New South Wales	30	10	20	320	310	150
Queensland				80	80	(a)
West Australia					20	10
	20,800	21,440	[c] 24,400	[c] 35,400	[c] 78,700	[c] 54,300

[a] No data.
[b] Incomplete data; actual production probably larger.
[c] Totals for years 1914–1917 include estimates of production of countries for which data are lacking.


ARCTIC
SIBERIA
BERING SEA
ASIA
JAPAN
PHILIPPINE IS.
BORNEO
SUMATRA
NEW GUINEA
DIAN
OCEAN
AUSTRALIA
NEW ZEALAND
160°
180°
80°
100°
120°
140°
160°
60°
40°
20°
0°
20°
40°
60°

FOREIGN DEPOSITS.

NORTH AMERICA.

CANADA.[1]

Production of antimony ore in Canada has been extremely irregular. During periods of high prices a considerable output has been obtained; the years of maximum production were 1898 and 1907, when shipments of 1,344 short tons and 2,016 short tons, respectively, were made. Mining ceased in 1910 and was not resumed until 1915. The statistics of the antimony industry in Canada in recent years are as follows:

Antimony produced in Canada, with imports and exports, 1913–1917, in short tons.

Year.	Ore produced.		Smelter production of metal.	Exports of ore.	Imports.	
	Total.	Metal content.			Metal.	Salts.
1913					334	12
1914					324	23
1915	1,341	525	30	1,149	981	34
1916	885	375	54	794	398	21
1917	361	(a)	(a)	(a)	(a)	(a)

a No data.

The principal producing district in Canada is at West Gore, Nova Scotia, where the ore in addition to antimony contains from 2 to 4 ounces of gold to the ton. Other regions that have produced antimony ore are New Brunswick (York County), British Columbia, Quebec, and Yukon Territory. In British Columbia (Slocan district) and Yukon Territory (Chieftain Hills) antimonial lead ores are also worked. The Nova Scotia ores, which furnished the bulk of the production, have been exported to England. The small production of refined antimony came chiefly as a by-product of lead refining at the smelter of the Consolidated Mining & Smelting Co., at Trail, British Columbia; a small quantity of antimony was also smelted from antimony ores by the New Brunswick Metals (Ltd.), formerly the Canadian Antimony Co., at Lake George, New Brunswick.

Canada appears to be in about the same position as the United States with reference to antimony mining. High prices continued over a long period will bring out a considerable production, but no output is to be expected at peace-time prices.

MEXICO.[2]

Deposits of antimony exists in many parts of Mexico, and a considerable quantity has been produced for many years. As in other countries the output was increased largely during 1915 and 1916. No reliable data as to mine production are available, but the following figures of exports to England and the United States give some idea of the extent of the industry:

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[1] Wilson, A. W. G., Mining of antimony ores in Canada: Canadian Min. Jour., Feb. 15, 1917.
Canada Dept. Mines, Mineral production, 1913–1917.
Imp. Inst. Bull., vol. 14, pp. 401–403, 1916.

[2] Flores, T., Los criaderos de antimonio de México: Boletín minero, vol. 1, pp. 193–195, 1916.
Orchard, J. E., Mexico: Political and commercial control, p. 15, 1918.
Weed, W. H., Handbook of Mines, 1918, pp. 1650–1651.
Imp. Inst. Bull., vol. 14, p. 403, 1916.

Antimony exported from Mexico, 1912–1918.

Year.	To England: Crude and regulus. (long tons).	United States (short tons).	
		Ore.	Metal.
1912	3,296		
1913	2,345		
1914	1,543		6
1915	(a)	520	
1916	(a)	1,339	
1917	(b)	1,775	730
1918	None.	1,449	2,660

a No data. b Probably none.

The production of metallic antimony for 1917 is reported as 2,141 metric tons.

The principal mines are in the Sierra Catorce, in the States of San Luis Potosi and Queretaro. The ores are mixed sulphides and oxides and carry from 5 to 50 per cent of antimony. A smelter with an annual capacity of 6,000 tons of metal was built at Wadley in 1900; the product formerly went principally to England, but since 1915 it has been marketed in the United States. The smelter and most important mines are owned by Cooksons, of England, through a subsidiary, the Republican Mining & Metal Co. American interests own other properties in the same region, and during the war a smelter was constructed at San Luis Potosi by the International Mining & Metal Co. In western Sonora, near the Gulf of California, there are deposits of oxidized ores which furnished a considerable part of the ore imported into the United States. These are owned by Americans. A large deposit of lead-antimony ore (jamesonite) at Zimapan, Hidalgo, owned by the Antimony Corporation, an American firm, has not yet reached a productive condition. Other deposits of possible importance are known in the States of Guerrero, Durango, Sonora, Mexico, Baja California, and elsewhere.

The disturbed condition of the country during the last few years has prevented a production of antimony commensurate with the probable capacity of the deposits. It is probable that production will be maintained in the future even during periods of low prices.

SOUTH AMERICA.

BOLIVIA.[1]

The production of antimony in Bolivia was negligible prior to the war, but under the stimulus of high prices large quantities of high-grade antimony ore were produced in 1915 and 1916. This ore was shipped principally to England until an embargo was placed on Bolivian ore in 1918. The chief producing region is in the southern part of the department of Potosi, particularly the Bustillo, Sur-Chicas, Nor-Chicas, and Porco districts. The ore is of high grade, the portion shipped averaging more than 50 per cent of antimony, but the veins are small and become barren at shallow depth. It is possible that the known deposits have been largely exhausted, and, although a recurrence of a like demand might result in new and valuable discoveries, it is not likely that Bolivia can be an important producer when prices are normal.

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[1] Min. Jour. (London), Jan. 16, 1915, p. 45; Aug. 3, 1918.
Mineral Industry for 1916.
Singewald and Miller, The mining industry of Bolivia: Eng. and Min. Jour., Dec. 9, 1916, p. 1005.
Soc. Chem. Ind. Jour., vol. 38, p. 9 R, 1919.
Bolivia, Comercio especial de Bolivia; exportacion, importacion, bancos, 1915, La Paz, 1916.
Information furnished to War Minerals Committee by Western Metals Co.

Ore shipments during the last few years have been as follows:

Antimony ore shipped from Bolivia, 1913–1918, in metric tons.

Country.	1913	1914	1915	1916	1917	1918 (first 5 months).
England	62	186	16,184	17,377	13,887	2,189
France			....	1,113	993	....
Spain			140	....	....	....
United States			1,599	4,258	3,460	727
	62	186	17,923	[a] 22,748	[a] 18,340	[a] 2,916

[a] Data from Western Metals Co. London Min. Jour. (Aug. 3, 1918) gives 25,845 metric tons as the production for 1916, and 21,287 metric tons as the production for 1917.

PERU.[1]

During the antimony boom of 1906–7 a small quantity of antimony ore was produced in Peru. No further production was made until 1915, when 522 tons of high-grade ore was mined. In 1916 the production rose to 1,876 tons of 60 per cent ore. The production in 1917 was 902 tons. Although deposits are known in many parts of the Republic, particularly the Departments of Huanuco, Ancachs, La Libertad, Cajamarca, and Junin, more than 90 per cent of the production has come from the Department of Puno, in southern Peru. Up to the present time it has been possible to mine antimony only during periods of high prices, but the deposits are said to be extensive, and it is possible that improved transportation facilities would result in some production under normal conditions.

Most of the ore produced in 1917 is said to have been exported to Japan.

EUROPE.

AUSTRIA-HUNGARY.[2]

The most important antimony deposits of the former Empire of Austria-Hungary are those of Hungary and Bohemia. Others of minor importance are those of Trojana in Carniola and Lessing in Austria. The Hungarian deposits in 1913 furnished 11,017 tons of ore, containing 1,038 tons of metal. Austria produced 1,270 tons of ore, chiefly from one mine in Carniola, with minor quantities from small mines in Bohemia, but the metal production was only 89 tons. The low antimony content of the Hungarian deposits is compensated by the gold content, and these deposits have been much more regular in production than those of the other parts of the empire. So far as known the reserves are fairly large, but production can hardly be expected to increase greatly.

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[1] Weckwarth, E., Antimonio en Perú; Cuerpo Ing. Minas Bol. 68, 1909.
Estadística minera del Perú, 1915–1917.
Information supplied by Western Metals Co.

[2] Prindle, L. M., MS. report on antimony deposits in Europe, U. S. Geol. Survey, 1918.
French Ministry of Blockade, report on antimony, 1917.
Imp. Inst. Bull., vol. 14, pp. 392–393, 1916.
Austrian and Hungarian official statistics.

The productive capacity of both the Hungarian and the Bohemian deposits is probably sufficient to supply local needs in normal times and allow a surplus for export under favorable economic conditions. Prior to the war exports of regulus went to Germany and small quantities of ore to France and England. During the war the Central Empires probably depended largely on the Austro-Hungarian deposits for their antimony supplies. All the mines were operated by the Government, and the output is unknown. It is known, however, that certain mines which had previously been abandoned resumed operations, so it is probable that the output was considerably increased.

FRANCE.[1]

France is the largest antimony producer in Europe and also controls important productive deposits in Algiers and Indo-China. The following table gives the figures of French production as far as they are available:

Antimony produced in France in 1912 and 1913, in metric tons.

Year.	Mine production.		Smelter production.
	Ore.	Metal content.	Regulus and oxide.
1912	11.018	2,392	5,406
1913	20,872	6,467	6.390

The principal producing regions of France are Vendée, Mayenne, Cantal, and Haute Loire. The French deposits are numerous, but for the most part small. The most important of them is La Lucette, in Mayenne, where stibnite associated with auriferous pyrite has been mined for many years. This deposit was considered to be approaching exhaustion, but it is reported that recent work has developed new ore bodies. The Lucette Co. has recently extended its holdings in other parts of France and has purchased properties in Algiers and the Transvaal, and in 1911 it leased a smelter at Barcelona for the treatment or ores purchased abroad. The Lucette Co. is also associated with the Antimony & Compounds Co. of America.

France is normally an exporter of metallic antimony and the average annual exports during the period 1910–1914 amounted to about 2,000 metric tons. The principal purchasers were the United States, Germany, Italy, The Netherlands, and Russia. According to recent information,[2] the surplus production of antimony in France is now so large that the industry can hardly continue to exist on a paying basis, unless the producers come to an understanding among themselves. It is clear, however, that to be effective, any agreement among French producers must either be backed by a high protective tariff or be extended to include their principal foreign competitors.

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[1] French Ministry of Blockade, report on antimony, January, 1917.
Prindle, L. M., MS. report on antimony in Europe, U. S. Geol. Survey, 1918.
Imp. Inst. Bull., vol. 14, pp. 393–395, 1916.
French official statistics, 1912 and 1913.

[2] Eng. and Min. Jour., vol. 107, p. 371, Feb. 22, 1919.

During the war France imported much antimony ore.

Antimony ore imported into France, 1916–1918, in metric tons.[1]

1916	10,697
1917	13,665
1918	2,015

GERMANY.

The antimony production of Germany is too small to affect the world's market appreciably. There are a few localities that have possibilities of production if the price of antimony is sufficiently high. It is reported, that one plant in the Eifel district in 1915 was producing from 25 to 30 tons of regulus and 60 to 70 tons of oxide a month. There is, however, a production of antimonial lead from the smelters that may amount to the equivalent of 1,000 tons or more of antimony a year. This is derived in part from many German ores, especially the lead-zinc ores, and in part from ores of foreign origin.

Germany's interest in the antimony market is chiefly that of a smelter and middleman. Her average annual imports in 1910–1913 were as follows: Ore, 3,668 metric tons; metal, 3,398 tons; salts, 668 tons. Average annual exports were: Ore, 566 tons; metal, 331 tons; salts, 1,226 tons. The principal purchasers of the metal were the United States and Russia and of the salts Russia and England.

GREAT BRITAIN.[2]

Although deposits of antimony in Cornwall, Devon, and elsewhere were formerly worked, no antimony has been mined in England since 1892. England, however, was prior to the war the chief smelting center of the world, several brands of British antimony, such as Cookson's and Hallett's, having a world-wide reputation. Deposits of considerable size exist in many of the British possessions.

England, through her smelting interests, has in the past played an important part in the antimony trade of the world. Seven smelters in England refine ore and crude metal, chiefly from China but also from Mexico, Australia, and Hungary, and, during the war, large quantities from Bolivia and Spain. The better British brands have been considered purer than other grades and prior to the war virtually monopolized American markets.

British trading interests have exerted a large influence both in obtaining raw material for British smelters and in obtaining markets for British metal.

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[1] Écho des mines et de la métallurgie, Mar. 27, 1919, quoted in Eng. and Min. Jour., vol. 107, p. 844, 1919.

[2] Imp. Inst. Bull., vol. 14, pp. 389–417, 1916.
French Ministry of Blockade; report on antimony, 1917.

Until 1914 the Chinese Eastern Antimony Co., a subsidiary of Cookson & Co., held contracts for the output of the Wah Chang Mining & Smelting Co., the most important antimony producer in China, since, in addition to the mining of antimony ore, it controls the local smelting industry. In 1914 the Wah Chang Co. established an independent selling agency in the United States.

ITALY.[1]

Italy ranks third as a producer of antimony in Europe. The principal deposits are those in the southern part of the island of Sardinia. During the war, however, the Tuscan deposits were reopened, and there was also a small production from Sicily. The grade of the ore is low, probably averaging less than 25 per cent, and the production, which was 7,609 tons of ore in 1900, had fallen in 1913 to 1,822 tons.

Antimony ore produced in Italy and metallic antimony imported, 1912–1917.

Year.	Ore produced.		Metallic antimony imported (metric tons).
	Quantity (metric tons).	Metal content (per cent).	
1912	1,878	20	....
1913	1,822	25	....
1914	555	24.5	191
1915	4,334	20	825
1916	6,509	....	155
1917	5,789	....	1,247

The low metallic content of the ore, together with the fact that in the Sardinian deposits the calcite gangue makes recovery more difficult, renders it probable that under peace-time conditions and prices Italy will not be an important factor in the world's production of antimony.

PORTUGAL.[2]

A small quantity of antimony ore was produced in Portugal—100 tons in 1912 and 19 tons in 1913. Exports of ore from Portugal in 1916 are said to have exceeded 4,000 tons. Nothing is known as to the grade of the ore or the possibilities of development. Mining methods are said to be crude and wasteful.

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[1] Prindle, L. M., MS. report on antimony in Europe, U. S. Geol. Survey, 1918.
French Ministry of Blockade, report on antimony, 1917.
Imp. Inst. Bull., vol. 14, p. 395, 1916.
Italian official statistics.

[2] Prindle, L. M., MS. report on antimony in Europe, U. S. Geol. Survey, 1918.
French Ministry of Blockade, report on antimony, 1917.
Imp. Inst. Bull., vol. 14, pp. 395–396, 1916.

RUSSIA.[1]

Antimony and argentiferous lead-antimony deposits occur in the Ural Mountains and were reported to be under development in 1912. Antimony deposits are also reported in the Amur Province and in many localities in Siberia. It is possible that productive deposits may be developed in these regions, but nothing definite is known with regard to them.

In 1915 67 tons of regulus was imported into England from Russia, Possibly, however, this represents an overland shipment of Chinese material.

SERBIA.

Serbia contains several deposits of antimony of considerable promise, but the production has been small. No data are available for years since 1912, and it is not known whether there was an increased production under German occupation. The output of regulus and oxide, which amounted to 4,725 metric tons in 1904, had decreased to 297 metric tons in 1912. The greater part of the product was formerly shipped to the United States. Plants at two of the mines were said to be capable of a considerable production should conditions warrant it.

SPAIN.[2]

Deposits of antimony are known in many localities in Spain. For the most part the ore bodies are irregular and have been repeatedly worked and abandoned. In a few deposits, however, there appears to be some promise of a continued production. The production of ore and metal in recent years has been as follows:

Antimony ore and metal produced in Spain, 1911–1917, in metric tons.

Year.	Mine production of ore.	Smelter production of metal.	Year.	Mine production of ore.	Smelter production of metal.
1911	100	(a)	1915	300	(a)
1912	500	(a)	1916	516	425
1913	....	(a)	1917	502	(a)
1914	....	(a)			

a No data.

Shortly after the outbreak of the war three smelters were active, the largest of which was operated by the Lucette Co. (French).

Spain formerly imported annually 800 tons of antimony ore from France and prior to the war exported annually more than 100 tons of salts of antimony to Germany.

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[1] De Hautpick, E., Min. Jour. (London), vol. 97, p. 620, 1912.
Imp. Inst. Bull., vol. 14, p. 396, 1916.

[2] Estadística minera, 1912–1917.
Prindle, L. M., MS. report on antimony in Europe, U. S. Geol. Survey, 1918.
French Ministry of Blockade, report on antimony, January, 1917.

ASIA.

BORNEO.[1]

British Borneo was formerly an antimony producer of considerable importance and exported much ore between 1859 and 1894, mainly to England. The deposits then remained idle until 1914, when 870 tons of ore was exported; in 1915 the exports amounted to about 350 tons. It is probable that no large production at peace-time prices is to be expected, although the country is largely unexplored and there is the possibility of future valuable discoveries. The Borneo Co. appears to have been the principal if not the only producer.

CHINA.[2]

Since 1908 more than 50 per cent of the world's production of antimony has come from China. In 1913 the production was estimated to be the equivalent of 11,000 metric tons of recoverable metallic antimony, and that of the whole world was about 21,000 tons. Being well established, the Chinese antimony industry was able to respond rapidly to the great demand of the war, and the annual production has been more than doubled since 1914.

No figures for production are available but exports in recent years have been as follows:

Antimony exported from China, 1913–1917, in short tons.

	1913[a]	1914[a]	1915[b]	1916[b]	1917[c]
Regulus	14,361	21,649	2,115	24,740	16,337
Crude			10,664		21,805
Ore	4,795	5,479	1,843	81,964	8,667

[a] Imp. Inst. Bull., vol. 14, p. 392, 1916.
[b] Commerce Repts., Dec. 19, 1917.
[c] Steel and Metal Digest, p. 514, August, 1918.

Antimony is found over widely scattered areas in the central and southern provinces, but principally in Hunan, Yunnan, Kweichow, and Kwangsi.

The deposits in Hunan have been most extensively exploited, probably 90 per cent of the total production of China coming from the region about Changsha, the center of the smelting industry.

The most productive district in Hunan is Hai-keng-shan (Shikungshan) in the valley of Tzu River, about 21 miles east of the Hsinhua. In 1915 about 70 companies mined antimony along the outcrop of the deposits in this district. The ore, which is mainly stibnite of remarkable purity, occurs as pockets and bunches in a flat bed of dolomitic limestone. Mining is carried on in a crude fashion by natives. Several local smelters produce liquated sulphide, and the output of the district in 1915 was about 1,000 tons monthly of crude ore averaging about 70 per cent metallic antimony. All regulus manufacture is controlled by the Wah Chang Co.

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[1] Posewitz, T., Borneo, its geology and mineral resources, London, 1892.
Imp. Inst. Bull., vol. 14, p. 397, 1916.

[2] Imp. Inst. Bull., vol. 14, pp. 397-399, 1916.
Moore-Bennet, A. J., The mineral area of western China: Far Eastern Rev., vol. 12, pp. 223–224, 1915.
Wheler, A. S., Metalliferous mines of Hunan Province: Far Eastern Rev., vol. 12, p. 135, 1915.
Wheler, A. S., Antimony production in Hunan Province, South China: Inst. Mining and Metallurgy Bull. 137, 1916.
New atlas and commercial gazetteer of China (compiled by the Far Eastern Geographical Establishment), North China Daily News and Herald (Ltd.), Shanghai.

The Panshi district, which produces considerably less, is 25 miles from Chan-shi, on Tzu River, in a very mountainous region. The ore in this district occurs in a series of veins in upturned slates, shales, and quartzites. The output of the district in 1915 consisted of about 400 tons monthly of 30 per cent ore, all of which was shipped to the Wah Chang Co., at Changsha, for treatment.

Other producing districts in Hunan are the Wa-shi district, east of Shenchowfu; the Hua-pan-hsi district, in Anhwa, and the Chiang-hsi-lung district, in Chupu-hsien.

The only district in Yunnan where antimony is handled commercially is near Chihtsun, on the Tongking-Yunnan Railroad above Mengtse. The Pao Hua Co., connected with the Wah Chang Co., own a French-constructed plant here and produces high-grade regulus.

The Wah Chang Mining & Smelting Co. largely controls the production of antimony ore, regulus, and crude in the province of Hunan. This company operates smelters in Changsha and owns certain mines of low-grade ore. It possesses a complete monopoly, granted by the Peking government, for the manufacture of regulus in Hunan and owns the patent rights in China for the Herrenschmidt furnace, the most successful means of reducing low-grade antimony ores. Most of the mines themselves are owned by natives and operated in a small way.

Prior to the war exports of Chinese antimony were chiefly in the hands of English, French, and a few German firms. The New Chinese Antimony Co. (also known as the Chinese Eastern Antimony Co.), a subsidiary of Cookson & Co. of England, held a contract for the entire output of the Wah Chang Co. This contract was broken shortly after the war began, although the Wah Chang Co. paid a percentage on all sales to the New Chinese Antimony Co. for a year thereafter. The Wah Chang Trading Co. was organized as a direct selling agency in New York and has established a large business in this country.

Adverse exchange conditions due to the high price of silver have probably nearly doubled the cost of production in China, and at the same time wages in that country have advanced.

Chinese antimony, which suffered from lack of advertising before the war, being largely excluded by the British metal in this country, has now become firmly established in our markets.

INDIA.[1]

During the war small amounts of antimony have been produced in Burma and Mysore. The total Indian production of antimony ore was 1,040 tons in 1916 and 130 tons in 1917. The most productive region was the Amherst district of Burma. The ore reserves are said to be considerable, but the inaccessibility of the district has made production impossible except at high prices. No data are available as to the grade of ore shipped. The production from Mysore was only 26 tons in 1916. Antimony deposits, not worked at present, occur at several places in the Punjab and in the southern Shan States.

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[1] Imp. Inst. Bull. vol. 14, p. 398, 1916.
India Geol. Survey Records, vol. 49, pt. 1, p. 13, 1918; pt. 2, p. 74, 1918.

INDO-CHINA.[1]

There are productive deposits of possible future importance in French Indo-China. In 1916 these deposits produced 1,437 tons of antimony ore having a metal content of 642 tons. Smelters were operated by the firm of Schon & Rhay, and both native and Chinese ores were treated.

In 1914 and 1915, respectively, 883 and 630 tons of antimony ore were exported from Indo-China to France.

JAPAN.[2]

Very little antimony ore has been produced in Japan since the development of the Chinese deposits, although, as in most other countries, there has been a renewed development during the war. The smelting of Chinese ores has become an important industry, and the smelter production, which was only 32 tons in 1914, rose to 8,189 tons in 1915 and to 10,633 tons in 1916. It was 6,562 tons in 1917. The production of metal and crude from domestic ores was only 186 tons in 1915 and 286 tons in 1916.

It is probable that as long as cheap ore is available in China little production from Japanese deposits can be expected.

The extent to which Japanese ownership has been extended to Chinese mines is not known but is probably small, as practically all Chinese antimony bought by Japan has been purchased in the open market in the form of crude and ore.

Since 1914 Japan has played a very considerable part in the smelting of Chinese ore and matte, ranking second only to China herself. China is now in a position to supply direct the major part of the world's requirement of metal, having largely extended her facilities for treating antimony ores, and it is doubtful whether Japanese smelters will long be able to compete successfully with the Chinese.

As most of the ships available on the Pacific during the war were Japanese, most of the antimony trade was in Japanese hands, and Japanese firms could land antimony in New York by way of Panama more cheaply than other firms. How far this control will be continued or extended under a return to normal conditions is problematic.

TURKEY.[3]

The production of antimony in the Turkish Empire comes from the vilayets of Brussa and Smyrna, particularly the region between Kutaya and Aidin, in eastern Asia Minor. The deposits appear to be rich and capable of greater development. Bad government, lack of transportaton facilities, and excessive export duties have retarded production. Some mines were the property of the Sultan, and their development was hindered by excessive royalties. Most of the mines appear to be owned or leased by Greeks. Deposits of antimony ores associated with argentiferous lead ores are reported to occur in the vicinity of Karahissar, in Armenia. Undeveloped deposits of possible importance occur in the islands of Mytilene and Chios, now in Greek ownership. The productive district of Allchar, formerly in European Turkey, was acquired by Serbia after the Balkan War.

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[1] Far Eastern Rev., vol. 13, p. 159, 1916.
Eng. and Min. Jour., vol. 107, p. 371, 1919.
Commerce Repts., June 25, 1917, p. 1140.

[2] Bliss, E. F., and Grout, F. F., MS. report to War Trade Board, 1918.
French Ministry of Blockade, report on antimony, Jan. 31, 1917.
Imp. Inst. Bull., vol.14, p. 399, 1916.
Commerce Repts., Feb. 19, 1919, p. 796.

[3] Simmersbach, B., Die nutzbaren mineralischen Bodenschätze in der klein asiatischen Turkei: Zeitschr. für Berg, Hutten u. Salinenwesen, vol. 52, p. 533, 1904.
Doelter, C., Die Mineralschätze der Turkei: Montan, Rundschau, vol. 8, p. 219, 1916.
Dominian, L., Mineral resources of the Turkish Empire: Min. and Sci. Press, vol. 98, p. 824, 1909.
Weiss, K. G., Mitteilungen über Lagerstätten in westlichen Anatolien: Zeitschr. prakt. Geologie, vol. 11, p. 255, 1901.
Schmeisser, C., Bodenschätze und Bergbau Kleinasiens: Zeitschr. prakt. Geologie, vol. 14, p. 192, 1906.
Thomae, W. F. A., Emery, chrome ore, and other minerals in the vilayet of Aidin, Asia Minor: Am. Inst. Min. Eng. Trans., vol. 28, p. 221, 1898.
Harris, E. L., consular report quoted in Eng. and Min. Jour., vol. 84, p. 689, 1907.
French Ministry of Blockade, report on antimony, Jan. 31, 1917.

Few data are available as regards the production of antimony in Turkey. In 1911 the Djinli Kaya mine, near Eudemish, produced 1,500 tons of 50 per cent ore. The production of Asia Minor in 1912 is reported as 677 tons of ore. Exports of antimony ore from Turkey to Great Britain were 303 metric tons in 1910, 773 tons in 1911, 1,091 tons in 1912, 402 tons in 1913, and 199 tons in 1914. Some ore was also shipped to Austria, and in 1913, 205 tons went to France.

It seems probable that, given good government and improved transportation, an increased output could be obtained from the region even at peace-time prices, as according to the best available information the deposits are large and much of the ore is of high grade.

AFRICA.

ALGERIA.[1]

The Algerian deposits are probably capable of considerable development, as is shown by the response to the increased demand in 1915 and 1916. The ores are nearly all oxidized and contain various rare antimony minerals. Prior to the war the chief product consisted of antimonate of iron mined together with lead and zinc ores at Haman N'Bails. During the war large deposits of oxide ores were developed at Aīn Kerma and were reported to be supplying antimony to France at the rate of 300 tons a month in the early part of 1918. The following table shows the mine production during recent years.

Antimony ore produced in Algeria, 1912–1916, in metric tons.

Year.	Ore.	Metal content.
1912	4,661	1,771
1913	582	233
1914 [a]	1,100	400
1915 [a]	9,022	3,422
1916 [a]	28,473	11,176

[a] Exports, metal content approximate only.

BRITISH SOUTH AFRICA.

Several antimony deposits are known in British South Africa, of which the most promising appear to be those of the Murchison Range,[2] in northern Transvaal. Here auriferous stibnite occurs as veins and replacement deposits in limestone over a considerable area. The ore as mined carries from 3½ to 8 pennyweights of gold ($3.60 to $8.25) to the ton and 7 to 10 per cent of antimony.

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[1] Dussert, Étude sur les gisements métallifères de l'Algérie: Annales des mines, 10th ser., vol. 7, 1910.
French official statistics.
French Ministry of Blockade, report on antimony, 1917.
Écho des mines et de la métallurgie, vol. 46, p. 297, June 16, 1918.

[2] Hall, A. L., Geology of the Murchison Range: South Africa Geol. Survey Mem. 6, 1912.
Union of South Africa, Reports Govt. Mining Engineer, 1914–1917.

Concentrates and crude antimony shipped from Transvaal, 1913–1917, in metric tons.

1913	48	1916	722
1914	0	1917	617
1915	91		

The principal mine of the range, the United Jack, was purchased in 1917 by the Lucette Co. (French). In 1916 there were four producing mines in the district.

The antimony deposits of the Steynsdorp district,[1] near the Swaziland border, were reported to be under development in 1916, and deposits of antimony ore are known in the Forbes Reef district, in Swaziland.

Antimony ores are found over a considerable portion of southern Rhodesia,[2] and this district would probably be capable of a considerable output with better transportation facilities and continued high prices. The ore produced in 1916 and 1917 amounted to 38 and 15, tons, respectively. Some of the mines, such as the Hope Fountain, near Bulawayo, are valuable chiefly for their production of gold, with antimony as a minor by-product.

AUSTRALIA.[3]

The only important antimony-producing district in Australia is the Costerfield district of Victoria. Here stibnite and antimony oxides occur in quartz veins cutting Ordovician slates.

The antimony concentrates, which average about 48 per cent of antimony and also contain about 2½ ounces of gold to the ton, are shipped to England.

The output in recent years has been as follows:

Antimony concentrates produced in Victoria, 1913–1916.

Year.	Quantity (long tons).	Value.
1913	2,527	$152,830
1914	2,439	142,745
1915	[a] 3,200	....
1916	3,259	375,828

[a] Approximate.

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[1] South African Min. Jour., vol. 25, pt. 2, p. 479, Aug. 26, 1916.
Molengraaf, G. A. P., Géologie de la République sud-africaine: Soc. Géol. France Bull., 4th ser., vol. 1, p. 28, 1901.

[2] South African Min. Jour., vol. 25, p. 465, Aug. 19, 1916.
Reports of the Secretary of Mines of Rhodesia, 1916–17.

[3] Official statistics, Victoria and New South Wales.
Imp. Inst. Bull., vol. 14, pp. 405–408, 1916.
Caine, J. E., The antimony mining industry in New South Wales; New South Wales Dept. Mines, Min. Res. 16, 1912.

The Hillgrove district, in New South Wales, was formerly a considerable producer, the highest annual output being 2,450 tons of ore in 1906.

Antimony metal and ore produced in New South Wales, 1912–1917.

Year.	Quantity (long tons).	Value.
1912	62	$1,727
1913	18	1,979
1914	36	2,252
1915	632	60,885
1916	616	64,850
1917	301	18,180

Apparently the greater part of the production is shipped as crude.

Insignificant quantities of antimony ore have recently been produced in Queensland and Western Australia. New Zealand produced a small quantity during the boom of 1906 and 1907, but no production is recorded since 1910.

Imports of antimony ore into Great Britain from Australia in 1915 amounted to 3,854 long tons, valued at $471,700.

SILVER, COPPER, LEAD, AND ZINC IN THE CENTRAL STATES.

(MINES REPORT.)

By J. P. DUNLOP and B. S. BUTLER.

INTRODUCTION.

By J. P. DUNLOP.

The following is an account of the production of silver, copper, lead, and zinc in 1918 by the mines of the Central States, including Arkansas, Illinois, Kansas, Kentucky, Michigan, Missouri, Oklahoma, and Wisconsin. The territory thus embraced lies in the great interior valley province of the United States which extends from the Appalachian system to the Rocky Mountain front, excluding the Black Hills. Most of the mines are developed in the Paleozoic sedimentary rocks of this province, but the copper range of northern Michigan comprises lavas and intercalated sediments of pre-Cambrian age.

The statistics of production in these States have been compiled by the United States Geological Survey from confidential reports by each mine in operation and represent the quality of metals recovered or paid for in the ore that was treated or sold during the year.

The method of marketing and recording the mine output in the lead and zinc regions of the United States differs from that employed in the Western States. In the Western States the miner usually sells his ore according to the assay content of metal at a certain price per unit. In the lead and zinc regions of the Central States, however, where the material sold is principally concentrates,[1] payment is made according to a basis price for a certain quality of concentrates. The details of this method are given in the pages devoted to Missouri in this report for 1914. The figures reported to the Survey by producers represent the quality and assay content of concentrates sold and the amount received in payment. The total metal produced is calculated from the first two of these items.

The operators in Michigan report the quantity of concentrates produced and the actual recovery of copper from concentrates smelted. In any year the mines may produce more or less concentrates than are smelted during the same period. The copper content of concentrates produced but not smelted during the year has been estimated on the basis of the average copper recovery per ton for the year of the company producing it.

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[1] In local usage the ore as mined is called "dirt" and the concentrates are classed as "ore." Where the capacity of a concentrating plant is given, such capacity is to be understood as based on a 10-hour shift unless otherwise stated.

TENOR OF LEAD AND ZINC ORES OF THE CENTRAL STATES.

Much of the ore mined in the Western States is crude smelting ore; that is, it can be smelted directly without preliminary concentration. All but a very small portion of the ore from the Central States is of such tenor that it requires concentration. The only fair basis for comparison of the relative magnitude of mining operations in different States is that of quantity of crude ore, or "dirt," as it is usually called in the lead and zinc regions of the Central States. In the Joplin and upper Mississippi Valley regions the number of cans of ore hoisted is usually recorded and the approximate weight of the cans is generally known. Thus each company knows, in a general way, about what percentage of concentrates the run of mine is yielding. Knowing the total production of concentrates and the average yield of concentrates from crude ores, one can arrive at a close estimate of the crude ore raised. Only the actual operating companies have the data, however, and it was the practice of the Survey, in order to shorten the list of producers as much as possible, to send requests only to the owners of the mining land or the companies holding first leases and to depend upon them to report the whole production of the tract. Since 1911 not only the first lessees of the land have reported to the Survey, but also most of the sublessees have given data regarding both concentrates produced and "dirt" or ore milled. The tables of tenor of ore which follow in the sections devoted to the respective States show the comparative percentages for the last two years.

In Kentucky and southern Illinois the lead and zinc concentrates are recovered as by-products in the concentration of the fluorspar which they accompany, and it was not possible to make calculations of the metal content of the crude ore raised.

Tenor of copper, lead, and zinc ores of Central States, 1916–1918.

State.	1916		1917		1918	
	Crude ore.	Metal content.[a]	Crude ore.	Metal content.[a]	Crude ore.	Metal content.[a]
	Short tons.	*Per cent.*	*Short tons.*	*Per cent.*	*Short tons.*	*Per cent.*
Arkansas	249,000	3.15	203,600	3.89	37,000	3.28
Illinois (northern)	288,100	1.60	327,340	1.81	280,900	2.10
Iowa	....	....	1,000	....	....	....
Kansas	774,400	1.98	903,400	2.82	1,025,400	3.97
Michigan	12,364,114	1.08	12,400,723	1.03	11,321,365	1.00
Missouri	[b]18,664,024	2.18	17,024,000	2.24	9,146,800	2.80
Oklahoma	1,406,900	3.13	3,523,200	3.45	5,754,700	4.11
Wisconsin	3,066,500	2.36	3,014,800	2.57	2,377,300	2.80
	36,813,038	....	37,398,063	....	29,943,465	....

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[a] The percentages given in this column represent the metal content of the ore in so far as it is recovered in the concentrates. In Michigan the metal so recovered is copper, in the other Central States the metals are lead and zinc, the relative proportions of which are shown in the table on another page and in the tables of tenor of ore given in the sections devoted to the respective States.

[b] A small quantity of copper ore included.

This table shows that from the copper, lead, and zinc mines of the Central States there was a decrease of about 7,455,000 short tons in the quantity of ore treated in 1918, following an increase of 585,000 tons in 1917. The production of ore from the copper mines of Michigan decreased 1,080,000 tons, and the production of ore in Missouri decreased more than 7,877,000 tons, of which decrease 5,785,000 tons was chargeable to the "sheet ground" mines. The mines of the disseminated lead district in southeastern Missouri decreased their output about 355,000 tons. Other States which had a decreased output of lead and zinc ore in 1918 were Illinois, Arkansas, and Wisconsin. The increase in 1918 in the other States were as follows: Oklahoma, 2,231,000 tons, and Kansas, 122,000 tons.

The low-average tenor of the metal content of all crude ore mined in the Central States in 1918 is best shown by the fact that the average value of the total recoverable metal content was only $5.02 a ton of crude ore treated, and that this value was $0.17 more than in 1917. The 18,622,100 tons of zinc, lead, and lead-zinc ores treated in the Central States in 1918 yielded lead and zinc concentrates which sold for $58,517,959, so that the mine operators realized an average of $3.14 a ton of ore mined and treated, against $3.10 a ton of ore realized in 1917. Both the quantity and value of lead and zinc concentrates and also the value of both metals were less in 1918 than in 1917. There were substantial increases in the mining and milling costs, so that many mines were not operated at a profit.

PRODUCTION.

The total value of the mine production of silver, copper, lead, and zinc in the Central States in 1918 was $149,388,066, a decrease of $30,861,398, or about 17 per cent, compared with the value for 1917. The total value of the production of these metals for the years 1907 to 1918, inclusive, was $1,142,967,331, of which $478,382,770 was for copper, $396,945,906 for zinc, $263,723,794 for lead, and $3,914,861 for silver. Only in 1915 and 1916 has the value of the recoverable zinc exceeded that of copper.

SILVER.

The production of silver in the Central States in 1918 was 564,577 fine ounces, which, at the price of $1 a fine ounce (17.6 cents higher than in 1917), was valued at $564,577, as compared with 757,323 fine ounces, valued at $624,034 in 1917. Nearly all the silver that is produced in the Central States is recovered incidentally in the production of other metals. Of this production, 509,467 ounces came from the copper lodes of Michigan, a decrease of 179,084 ounces. About one-sixth of the concentrates from lead ores mined in southeastern Missouri was desilverized and yielded most of the silver from that State recovered in 1918, and 7,892 ounces of silver were derived from copper ore and from copper concentrates recovered in dressing lead ores. The total recovery of silver from Missouri amounted to 46,939 ounces.

The lead-zinc-fluorspar deposits of the Kentucky-Illinois field also carry silver, and from the lead concentrates derived from Illinois 8,171 ounces of silver were recovered, an increase of 985 ounces.

COPPER.

The mine production of copper in the Central States in 1918 was from Michigan and Missouri, the first-named State, as in other years, contributing nearly the entire output, which amounted to 227,371,804 pounds. The copper production of Michigan in 1918 was 226,794,139 pounds, which, at the average sales price of 24.7 cents a pound, was valued at $56,018,152, as against a yield of 255,710,128 pounds, valued at $69,808,865, in 1917. The copper produced in Missouri in 1918, amounting to 577,665 pounds, valued at $142,683, was derived partly from concentrates recovered in dressing the lead ores of southeastern Missouri, but the larger part came from ore mined by the Missouri Cobalt Co., in Madison County.

The total mine production of copper from Michigan and Missouri in 1918 was about 28,700,000 pounds less than in 1917, and 46,000,000 pounds less than the output of 1916.

LEAD.

The mine production of lead in the Central States in 1918 was 264,635 short tons, which, rated at the average sales price for all grades for the metal for the year of 7.1 cents a pound ($142 a ton), was valued at $37,578,170, as compared with 269,656 short tons, valued at $46,380,832, in 1917. The output of lead decreased 5,021 tons in 1918, and the value $8,802,662. In 1918 Missouri produced 73 per cent of the yield of lead in the Central States, against 87 per cent in 1917, and the recoverable lead content of galena and lead carbonate concentrates mined in Missouri in 1918 equaled 36 per cent of the refined primary lead recovered in the United States from domestic ore. Of the total output of lead in Missouri, the "disseminated lead" district of southeastern Missouri produced 181,392 tons, a decrease of 22,863 tons, again exceeding the yield from the Coeur d'Alene district of Idaho and retaining first place in production of lead in the United States. Southwestern Missouri had an output of 12,783 tons, or 16,828 tons less than in 1917, and only about one-fourth the production from mines in Oklahoma in 1918. The Oklahoma production increased from 26,358 tons in 1917 to 56,097 tons in 1918, and the output of the Miami district in 1918 was more than three times as large as the combined output of all regions other than southeastern Missouri.

The production from Kansas mines increased from 3,025 tons in 1917 to 7,252 tons in 1918; Illinois from 1,439 tons to 2,273 tons; and Wisconsin from 4,139 tons to 4,533 tons. The total production of lead from mines in the southern Illinois-Kentucky region, Arkansas, and the upper Mississippi Valley region amounted to only 2.7 per cent of the output of the Central States.

ZINC.

The production of zinc in the Central States in 1918, based on mine returns with a deduction for separating and smelting losses, was 302,662 short tons, valued at $55,084,484. The value is computed at 9.1 cents a pound (zinc, $182 a ton), the average sales price reported by the smelters for all grades of the metal.

The output in 1918 was the second largest recorded yield from mines in the Central States, being less than that of the year 1917 by 7,809 tons. The value, notwithstanding the approximate equality of output, decreased $8,251,600. The production of zinc in the Central

States was about 61.5 per cent of the total production of primary zinc from domestic ores in the United States in 1918, against 53 per cent in 1917.

SUMMARY OF PRODUCTION BY STATES.

Mine production of silver, copper, lead, and zinc in the Central States in 1918.

State.	Silver.		Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Pounds.*		*Short tons.*		*Short tons.*		
Arkansas					120	$17,040	951	$173,082	$190,122
Illinois	8,171	$8,171			2,273	322,766	3,792	690,144	1,021,081
Kansas					7,252	1,029,784	30,197	5,495,854	6,525,638
Kentucky					185	26,270	315	57,330	83,600
Michigan	509,467	509,467	226,794,139	56,018,152					56,527,619
Missouri	46,939	46,939	577,665	142,683	194,175	27,572.850	55,992	10,190,544	37,953,016
Oklahoma					56,097	7,965,774	161,401	29,374,962	37,340,756
Wisconsin					4,533	643,686	50,014	9,102,548	9,746,234
Total, 1918	564,577	564,577	227,371,804	56,160,835	264,635	37,578,170	302,662	55,084,484	149,388,066
1917	757,323	624,034	256,075,141	69,908,514	269,656	46,380,832	310,471	63,336,084	180,249,464

For the first time the production of zinc in Oklahoma exceeded that of Missouri. For many years Missouri has been the largest producer of zinc in the United States, but the output from Missouri decreased from 132,918 tons in 1917 to 55,992 tons in 1918, while that of Oklahoma increased from 85,835 tons in 1917 to 161,401 tons in 1918. Kansas, which had an output of 30,197 tons on zinc, against 20,249 tons in 1917, will probably displace Missouri from second place in 1919. Wisconsin produced 50,014 tons in 1918 against 59,742 tons in 1917. Arkansas decreased in output from 6,691 tons to 951 tons; Kentucky from 751 tons to 315 tons; and northern Illinois from 4,267 tons to 3,792 tons. No production of lead or zinc was reported from Iowa mines in 1918.

LEAD AND ZINC PRODUCTION, BY REGIONS.

The productive lead and zinc territory in the Central States naturally falls into seven regions, three of which are not limited to any single State. For statistical purposes the tables showing the production of lead and zinc by States are necessary and are so given. For practical purposes, however, it is desirable to compile the production by the natural regions irrespective of State lines.

The seven regions are, in order of importance of output, (1) the Joplin region, comprising the district in southwestern Missouri, southeastern Kansas, and northeastern Oklahoma; (2) southeastern Missouri, containing the great disseminated lead deposits; (3) the upper Mississippi Valley region, including all the lead and zinc mines in southwestern Wisconsin, Iowa, and northwestern Illinois; (4) northern Arkansas; (5) the Kentucky-Illinois fluorspar region in southern Illinois and northern Kentucky; (6) central Missouri; (7) the Arbuckle Mountain region in southern Oklahoma.

The southeastern Missouri region produced about 68 per cent of the lead output of the Central States and about 33.6 per cent of the production of primary lead recovered from domestic ore smelted or refined in the United States in 1918. The Joplin region produced 28.8 per cent of the lead and 82 per cent of the zinc of the Central States in 1918, and was much the largest producer of zinc in the United States, yielding about 48 per cent of the total zinc production from domestic ores in 1918, as against 41 per cent in 1917. The upper Mississippi Valley region produced 2.3 per cent of the lead and 17.8 per cent of the zinc in the Central States in 1918.

The lower zinc content of the zinc concentrates produced in the upper Mississippi Valley region is clearly indicated by the fact that notwithstanding that the mines in the region yielded about 29 per cent of the total output of zinc concentrates of all classes the recoverable zinc content of such concentrates was only about 17.8 per cent of the recoverable zinc from mines in the Central States.

The lead content of the galena concentrates shipped from the upper Mississippi Valley region averaged 73.6 per cent, and those from the Joplin region averaged 79.7 per cent of lead.

Mine production of lead and zinc in the Central States in 1918.

Region.	Concentrates.				
	Lead.[a]		Zinc.[b]		Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	
Joplin	95,472	$8,497,637	469,829	$23,586,778	$32,084,415
Southeastern Missouri [c]	271,506	20,507,064	248	7,130	20,514,194
Upper Mississippi Valley	8,078	664,585	193,682	5,002,368	5,666,953
Kentucky-southern Illinois	1,483	123,630	927	30,390	154,020
Northern Arkansas	155	13,594	2,466	84,783	98,377
Total, 1918	376,694	29,806,510	667,152	28,711,449	58,517,959
1917	390,446	38,506,878	726,050	39,090,885	77,597,763

Region.	Metal.				
	Lead.		Zinc.		Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	
Joplin	76,132	$10,810,744	247,516	$45,047,912	$55,858,656
Southeastern Missouri [c]	181,392	25,757,664	74	13,468	25,771,132
Upper Mississippi Valley [d]	5,946	844,832	53,806	9,792,692	10,637,024
Kentucky-southern Illinois	1,045	148,390	315	57,330	205,720
Northern Arkansas	120	17,040	951	173,082	190,122
Total, 1918	264,635	37,578,170	302,662	55,084,484	92,662,654
1917	269,656	46,380,832	310,471	63,336,084	109,716,916

[a] Includes both galena and lead carbonate concentrates.
[b] Includes sphalerite, zinc carbonate, and zinc silicate concentrates.
[c] Includes a small production from the central Missouri region.
[d] Includes Iowa, northern Illinois, and Wisconsin.

The volume of Mineral Resources for 1914 contains brief reviews of the history of lead and zinc mining in the Central States, the yearly production of each State for the period 1907 to 1914, inclusive, and historical notes and estimates of the total production of lead and zinc produced in each State before 1907. The separate chapter entitled "Silver, copper, lead, and zinc in the Central States in 1914" can be obtained on application to the Director, United States Geological Survey, Washington, D. C.

ARKANSAS.

By J. P. Dunlop.

PRODUCTION.

The value of the recoverable lead and zinc from Arkansas mines, which had increased from $801,754 in 1915 to $1,430,668 in 1917, was only $190,122 in 1918. The decrease was caused almost entirely by the lower price of zinc concentrates.

The production of galena and sphalerite was only about one-third of that in 1917 and the total yield of these ores was small as compared with that of other regions. The shipments of zinc carbonate and zinc silicate concentrates in 1918 were one-seventh as large as in 1917.

Mine production of lead and zinc in Arkansas, 1907–1918.[a]

Year.	Ores.						Metal content.			
	Lead concentrates (galena).		Zinc concentrates.				Lead.		Zinc.	
			Sphalerite.		Silicate and carbonate.					
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1918	155	$13,594	310	$16,450	2,156	$68,333	120	$17,040	951	$173,082
1917	474	47,593	916	57,824	17,053	650,585	382	65,704	6,691	1,364,964
1916	339	28,097	1,670	112,726	16,609	940,224	272	37,536	6,815	1,826,420
1915	79	4,961	606	41,341	7,925	408,079	63	5,922	3,209	795,832
1914	52	2,408	743	19,406	1,143	25,187	41	3,198	608	62,016
1913	23	1,179	594	16,916	680	15,050	18	1,584	478	53,536
1912	39	2,180	1,419	56,235	462	11,231	31	2,790	748	103,224
1911	80	4,321	1,407	40,425	183	4,239	64	5,760	664	75,696
1910	80	3,714	1,857	74,136	128	2,641	63	5,544	994	107,352
1909	30	1,800	896	33,948	98	2,736	24	2,064	510	52,080
1908	18	985	516	18,270	939	21,469	15	1,260	605	56,870
1907	15	800	538	15,233	663	16,210	12	1,272	474	55,932

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses of zinc but not of lead. In comparing the values or ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead is calculated from the average sales price of all grades, and that of zince from the average sales price of all grades reported by the smelters.

Tenor of lead and zinc ore and concentrates produced in Arkansas in 1917 and 1918.

	1917	1918
Total crude ore........short tons..	203,600	37,000
Total concentrates in crude ore:		
Lead........per cent..	0.23	0.42
Zinc........do....	8.82	6.62
Metal contents of crude ore:		
Lead........do....	.19	.32
Zinc........do....	3.70	2.86
Average lead content of galena concentrates........do....	80.5	77.4
Average zinc content of sphalerite concentrates [a]........do....	58.4	59.0
Average zinc content of zinc silicate and carbonate [a]........do....	40.5	40.6
Average value per ton:		
Galena concentrates........	$100.41	$87.70
Sphalerite concentrates........	$63.13	$53.07
Zinc silicate and carbonate........	$36.15	$37.70

[a] Includes some mixed carbonate and sphalerite.

NORTHERN ARKANSAS.

Considerable prospecting and some mining were carried on in northern Arkansas for many years, but the present development has mainly been accomplished since 1899, when there was a great rush to that field. The mines are principally in Boone and Marion counties and in the adjoining portions of Searcy and Newton counties, though there are also numerous mines and prospects in Baxter, Izard, Sharp, Lawrence, and other counties to the east, and deposits have been worked in Washington and Sevier counties, on the extreme western border of the State.

The ores are galena, sphalerite, and smithsonite, and the concentrates produced are generally of high grade and free from or very low in iron or lime. The sphalerite has frequently assayed 2 or 3 per cent above the price basis of 60 per cent metallic zinc content. The sphalerite and smithsonite are shown by analysis to contain appreciable quantities of cadmium, especially in a yellow variety of smithsonite, known locally as "turkey fat," which shows as high as 0.8 per cent of cadmium. The ore bodies occur in fissures or crevices, in fault breccias, and in solution breccias. The ore deposits are for the most part found in limestone of early Ordovician age, but some also are found in the Boone limestone of Mississippian (lower Carboniferous) age.

The number of concentrating plants that treated sphalerite was 50 per cent less than in 1917 and all the plants were operated intermittently. Some mixed sphalerite and zinc carbonate concentrates were sold, and these shipments are partly given under sphalerite.

Most of the lead and zinc mines in Arkansas were not operated in 1918, and few of those from which concentrates were shipped were operated steadily. Considerable prospecting was done and several new milling plants were built. None of the new mills shipped any of their production, and at the end of the year there was a considerable quantity of both sphalerite and zinc carbonate in stock, so that the shipments reported do not represent the entire mine production in 1918. Several of the larger mine operators shut down their zinc properties in northern Arkansas and engaged in the mining of manganese ores near Batesville, Ark., and the scarcity of labor and high cost of supplies resulted in closing nearly all the zinc carbonate mines. Most of these mines have inexpensive equipment, no water to pump, and no leases requiring steady operation, so that work could be suspended until better prices were offered for zinc ores. These conditions explain why the reduction in the output of lead and zinc from Arkansas mines was greater proportionately than in the other regions of the Central States.

The estimated quantity of ore treated decreased from 203,600 tons in 1917 to 37,000 tons in 1918, and the average recovery of concentrates from such ore decreased from 9.05 per cent to 7.04 per cent. This decrease was the natural result of the decreased quantity of sphalerite ores and also of milled zinc carbonate.

There was no mine which yielded more than 500 tons of concentrates, and the entire production was from mines worked on a small scale, as is shown by the fact that the total shipments of all classes of concentrates, amounting to 2,621 tons, was derived from about 40 mines or prospects.

The Rush district, in Marion County, which was much the largest producer of zinc ore in 1916 and 1917, was very quiet in 1918, so that the Zinc district in Boone County took the lead in 1918 with an output which about equaled the combined output from all other districts in Arkansas. The assistance rendered to the Survey in obtaining statistics by Charles H. LeVasseur, R. W. Willett, J. T. Venable, and J. H. Hand, of Yellville, and by other mine operators, is gratefully acknowledged. It is to be regretted that many operators of mines in Arkansas, particularly the owners of small prospects, do not keep an accurate record of the quantity of dirt or ore mined and treated, the quantity of lead and zinc concentrates sold, the average assay of each class of concentrates, and the actual selling value of concentrates. In consequence, the figures given for quantity of ore mined and milled and the average recovery of concentrates from ore are necessarily approximate only.

The shipments of lead concentrates from mines decreased from 474 tons in 1917 to 155 tons in 1918. The production of sphalerite concentrates was 310 tons, or 606 tons less than in 1917, and the value decreased from $57,824 in 1917 to $16,450 in 1918. The sales of zinc carbonate concentrates decreased in quantity from 17,053 tons in 1917 to 2,156 tons in 1918, and the value decreased from $650,585 to $68,333. The recoverable lead content of galena concentrates shipped in 1918 amounted to 120 tons, valued at $17,040, and the recoverable zinc from zinc concentrates was 951 tons, valued at $173,082. Mines in Marion, Boone, Newton, Searcy, Baxter, and Lawrence counties produced all the zinc concentrates shipped in 1918, and mines in Newton County produced 141 tons of the total shipments (155 tons) of galena concentrates. Mines in Lawrence County shipped 14 tons of galena and 70 tons of zinc carbonate in 1918. The output was made by the Lucky Dog mill from dirt obtained from the Hoppe mine and from a mine operated by William Rubinger.

The shipments from Boone County were 150 tons of sphalerite and 1,095 tons of zinc carbonate. The shipments of zinc carbonate, which were about 2,300 tons less than in 1917, were mainly from mines in the vicinity of Zinc, especially from lessees on the Coon Hollow and Almy lands. A recent description of the mining properties near Zinc was written by Tom Shiras.[1] Most of the sphalerite was derived from the K. M. mine of the Continental Mining Co., 3½ miles southeast of Harrison, which was closed after a short run in the early part of the year.

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[1] Shiras, T., Operations at the Zinc camp, Ark.: Eng. and Min. Jour., Apr. 5, 1919, pp. 607–608.

More than 50 per cent of the ore shipped from Zinc in 1918 was taken from leases on the Almy land. The Gloria mill (capacity 50 tons) was operated by George C. Miller and the shipments from this property and from that of the McCurry Mining & Milling Co. were larger than from other districts. The McCurry mill, which was located in the town of Zinc, has since been removed to the Rhodes & Manchester land, 2½ miles north of Zinc.

A large part of the hand-cobbed zinc carbonate from Boone County was mined on the Coon Hollow lease, on Sugar Orchard Creek, by L. L. Brown. This land has produced by means of short tunnels into the hillside many thousand tons of high-grade zinc carbonate. The Rock Ore Products Co. in the Elixir district produced zinc carbonate and also did some drilling, which is reported to have shown ore bodies at depth.

From mines principally in the Cave Creek district, in the eastern part, and the Ponca and Jasper districts, in the western part of Newton County, there were shipped 141 tons of galena and 139 tons of zinc carbonate. Although the new Confederate mill at Cave Creek was not operated in 1918, there was some production of zinc carbonate shipped from the Bald Hill, North Slope, and other leases, on the lands of the American Zinc, Lead & Smelting Co. J. T. Venable, of Harrison, Ark., has acquired the Kilgore, Lake, Minicus, Hamilton & Young, and Whiteley leases on the Baker, Brewer, and Stevens land, near Ponca. These leases have for several years produced most of the galena shipped from Arkansas.

From the mines in Searcy County there was shipped in 1918 320 tons of zinc carbonate, which was less than 10 per cent of the quantity shipped in 1917. Most of the zinc carbonate came from the Big Hurricane mine of the J. C. Shepherd Mining Co., and the Howard Mining Co., which owns the Churchill, Evening Star, and Redwine mines in the Water Creek district, near St. Joe. Both mines were idle at the end of 1918.

The total shipments from mines in Marion County in 1918 were 160 tons of sphalerite concentrates, and 504 tons of zinc carbonate concentrates, which was 4 tons of galena, 552 tons of sphalerite, and 6,579 tons of zinc carbonate less than in 1917.

None of the mines were operated steadily and no large shipments were made. The mines at Rush, which were large producers in 1917, shipped only about 400 tons of zinc carbonate in 1918. Among the producing properties were the Morning Star, Monte Cristo, Philadelphia, Edith, Covert, and Liberty (Willett land). Most of the sphalerite came from the Bear Hill and Beatty mines. Of these properties the only ones now in operation are the Morning Star, the Beatty, and the Edith, which has been purchased by John de Costa. The Broome County mine, near Zinc, but in Marion County, was in operation for a few weeks, but the mixed concentrates produced at the mill were not sold in 1918. The 100-ton mill at the Tar Kiln mine was repaired by the Magnolia Lead & Zinc Co. and operated for about one month. The old Beatty mine near Kingdon Springs produced a small quantity of high-grade sphalerite. The property, which is equipped with a 100-ton mill, is now owned by J. H. Griffith. The Monkey Hill mine was also operated intermittently, but no sphalerite was shipped.

The Blue John mill and the Zinc Basin mine were purchased by the Okla-Ark Oil & Mining Co. The mill was not completley rebuilt in 1918 and the small quantity of hand-cobbed carbonate recovered during development was not sold. The Beulah and Hawkeye mines near Rush were taken over by the Arkansas Zinc Co., and some carbonate was shipped. A new 100-ton mill was under construction by the Mattie May Mining Co., at Rush, and considerable development was done. The Marguerite and Clear Creek mines near Everton are now owned by the Okizark Mining Co. Some concentrates were recovered by means of hand jigs in 1918, and a log-washing plant was under construction. Considerable development was done in the mines, and tramways and other surface equipment were installed.

The dry concentration plant of Sutton, Steele & Steele, at Yellville, was completed in 1918. Test runs were made on tailings from the Bear Hill and Willett mines in Marion County and also on crude ore from the McAllister mine near Bergman in Boone County. It is claimed that this plant will separate the mixed sphalerite and zinc carbonate ores which are abundant in many Arkansas mines. A description of the plant by Tom Shiras, of Mountain Home, Ark., is given in the Engineering and Mining Journal of November 23, 1918:

ILLINOIS.

By J. P. Dunlop.

PRODUCTION.

In the chapter entitled "Silver, copper, lead, and zinc in the Central States" of Mineral Resources for 1914 were given a historical review and a bibliography of the literature relating to the mining of lead and zinc in the northern and southern districts of the State of Illinois. Estimates were also given of the total quantity of concentrates and metal produced to the end of 1914.

Mine production of lead and zinc in Illinois in 1918.[a]

District.	Ores.				Metal content.			
	Lead concentrates (galena).		Zinc concentrates (sphalerite).		Lead.		Zinc.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Northern Illinois	1,868	$162,684	13,128	$377,100	1,413	$200,646	3,792	$690,144
Southern Illinois	1,228	102,564	....	....	860	122,120	....	....
	3,096	265,248	13,128	377,100	2,273	322,766	3,792	690,144
Total, 1917	1,984	197,182	18,221	477,003	1,439	247,508	4,267	870,468

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses of zinc, but not of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead is calculated from the average daily sales price (all grades) and that of zinc from the average sales price (all grades) reported by the smelters.

Mine production of silver in southern Illinois, 1907–1918.

	Silver.		Lead concentrates, silver bearing.			Silver.		Lead concentrates, silver bearing.	
	Quantity (fine ounces).	Value.	Quantity (short tons).	Ounces of silver per ton.		Quantity (fine ounces).	Value.	Quantity (short tons).	Ounces of silver. per ton.
1907	2,852	$1,882	497	5.74	1913	3,541	$2,139	507	7.00
1908	2,051	1,087	359	5.71	1914	2,112	1,168	308	6.86
1909	1,011	526	259	3.90	1915	3,864	1,959	641	6.03
1910	2,022	1,092	398	5.08	1916	5,684	3,740	874	6.50
1911	3,036	1,609	482	6.25	1917	7,186	5,921	1,239	5.80
1912	4,731	2,909	748	6.31	1918	8,171	8,171	1,228	6.65

Tenor of lead and zinc ore and concentrates produced in Illinois, 1917 and 1918.

	1917	1918
NORTHERN ILLINOIS.		
Total crude ore....short tons..	327,340	280,900
Total concentrates in crude ore:		
Lead....per cent..	.24	.66
Zinc....do....	5.56	4.67
Metal content of crude ore:		
Lead....do....	.18	.50
Zinc....do....	1.63	1.00
Average lead content of galena concentrates....do....	75.4	75.5
Average zinc content of sphalerite concentrates....do....	29.3	35.7
Average value per ton:		
Galena concentrates....	$99.83	$87.09
Sphalerite concentrates....	$26.18	$28.72
SOUTHERN ILLINOIS.		
Average lead content of galena concentrates....per cent..	70.7	70.0
Average value per ton of galena concentrates....	$99.10	$83.52

The lead concentrates produced in southern Illinois are recovered in concentrating the fluorspar. To speak of the total crude ore raised as crude lead ore would be misleading. No attempt has been made, therefore, at calculating the quantity or the tenor of the crude ore.

The value of the mine production of silver, lead, and zinc in Illinois in 1918 was $1,021,081, as compared with $1,123,897 in 1917. The lead concentrates produced amounted to 3,096 short tons, which was 1,112 tons more than in 1917, and the recoverable lead content increased from 1,439 tons in 1917 to 2,273 tons in 1918.

The output of sphalerite concentrates decreased from 18,221 tons in 1917 to 13,128 tons in 1918, the recoverable zinc contents of the concentrates decreased from 4,267 tons in 1917 to 3,792 tons in 1918, and the value decreased $180,324.

The silver recovered from lead concentrates amounted to 8,171 fine ounces, valued at $8,171, against 7,186 fine ounces, valued at $5,921 in 1917.

The lead and zinc deposits of Illinois fall into two distinct regions marked by different mineral association and structural environment. Those of southern Illinois belong to the Kentucky-Illinois fluorspar district; those of northern Illinois belong to the upper Mississippi Valley region.

NORTHERN ILLINOIS.

The lead and zinc mines of northern Illinois are all in Jo Daviess County, the extreme northwestern county of the State. The ores have the same structural relations as in the upper Mississippi district generally—that is, they occur disseminated through the limestone, or in openings in it called "crevices," "pitches," or "flats," depending on their attitude to the horizontal. These openings have, in general, an east and west trend, known as their "range." The ore bodies are sometimes continuous for long distances along these "ranges," which for that reason largely control the prospecting, both by shafts and by drilling. The ore deposits occur in the Galena dolomite and in the upper part of the Platteville limestone, both of Ordovician age.

The ores are galena, smithsonite, and sphalerite, though the two latter are much less common now than formerly, when the deposits worked were mostly shallow and above water level. In early years the galena ores only were mined and the ore was taken from shallow pockets in quantities ranging from a few tons to several thousand.

Although the lead output of northern Illinois, Wisconsin, and Iowa has been large in the past and the ores have been smelted near the mines,[1] the output in recent years has been comparatively small and no ores have been smelted in those States.[2] The galena is practically nonargentiferous, and the zinc ores are not known to contain cadmium. Iron pyrites is very commonly associated with the ores, generally in such quantity as to necessitate roasting and magnetic separation.

As none of the operators in the Sand Prairie district or in the Elizabeth district reported any production in 1918 the entire output of northern Illinois is included under the Galena district, which comprises the mines from the vicinity of Fever River to the Wisconsin State line.

The production of lead concentrates was 1,868 tons, valued at $162,684, as compared with 788 tons, valued at $78,666, in 1917.

There were 13,128 tons of sphalerite concentrates, valued at $377,100, produced in 1918, a decrease of 5,093 tons in quantity and of $99,903 in value.

The tonnage of crude ore mined decreased from 327,340 tons in 1917 to 280,900 tons in 1918. The average recovery of zinc concentrates from the ore milled decreased 0.47 per cent, and the percentage of lead was much greater than in 1917.

The average zinc content of the sphalerite concentrate increased from 29.3 per cent in 1917 to 35.7 per cent in 1918.

The largest production of lead and zinc concentrates in northern Illinois in 1918 was derived from the old Marsdon-Black Jack mine of the Mineral Point Zinc Co. The mill has a capacity of 600 tons in 24 hours and is driven by electric power. The mine is equipped with a steel head frame and a double-compartment mill shaft, and the ore is hoisted in skips. The North Unity mine, of the Vinegar Hill Zinc Co., was the second largest producer of sphalerite and the largest producer of galena in 1918. This mine was first operated in 1914 and is equipped with a 250-ton concentrating plant, which milled ore hoisted through a 175-foot shaft. About 20 drill holes were also sunk on the Curran land, on which the North Unity mine is located.

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[1] Cox, G. H., Lead and zinc deposits of northwestern Illinois: Illinois Geol. Survey Bull. 21, p. 14, 1914.

[2] Pulsifer, H. B., History of lead smelting in Wisconsin: Min. and Eng. World, May 2, 1914, p. 821.

The Graham mine, of the Vinegar Hill Zinc Co., which is also equipped with a 250-ton mill, had an output of sphalerite, about one-half that from the Unity mine. The Bartell & Sherrill sublease on the Graham land, which has for several years had a large production of lead taken from levels opened by shafts 45 to 60 feet in depth, was sold to the Osborne mine. There is a small 50-ton concentrating plant on this sublease. The Burr Mining Co. acquired the Blewett land in 1918, sunk a 206-foot shaft, and rebuilt the mill purchased from the Merry Widow Mining Co. No concentrates were sold in 1918.

More than 100 tons of galena were shipped in 1918 from the Yellow Rose mine, owned by Gus E. Brown, and the Eadie mine, owned by the Eadie Mining Co. The Eadie mine had two shafts in operation, through which galena ores were hoisted from the 85-foot level. The shaft at the White Rose mine is 72 feet in depth and is equipped with a hoisting and pumping plant.

A dry separating plant was built at the old Cleveland roaster in Galena by W. W. Bonson. This plant re-treated the tailings from the old dumps and made concentrates averaging 45 to 50 per cent of zinc content, which were not sold in 1918.

SOUTHERN ILLINOIS.

The lead and zinc deposits of southern Illinois are found in Pope and Hardin counties in rocks of Mississippian age in the northern extension of the Kentucky-Illinois fluorspar district.

The principal product of the mines in recent years has been fluorspar, and the yield of galena is small compared with the output from other districts in the Central States. The total production of galena concentrates for southern Illinois, 1906 to 1918, inclusive, has been 7,743 tons, most of which has been shipped from the Fairview and Rosiclare mines. The shipments of zinc ores from the district have been comparatively small and scattered. The only recorded shipments of zinc carbonate were made from the Empire mine in 1903 or 1904, and in 1906 four companies made shipments aggregating 103 tons.

The structural relations and the mineralogic association are similar to those of the deposits of western Kentucky and in striking contrast to those of the deposits of northern Illinois. The ores occur in fissure veins, in association with jointing and faulting. The mines have been worked to depths of 300 and 500 feet without disclosing any decrease in the dimensions of the ore bodies. Dikes and sheets of lamprophyre and dikes of mica peridotite occur in the vicinity, but not in direct connection with the ore deposits. Galena is the most important metallic mineral. Formerly, and nearer the surface, large bodies of galena were worked, but it is at present produced incidentally in the concentration of the fluorspar. For this reason it would be misleading to give the quantity of crude ore. As the district is not reached by railway, the product of the mines is dependent on river transportation.

The galena of southern Illinois is notably argentiferous as compared with the rest of the Mississippi Valley ores, the silver content being as much as 14 fine ounces per ton of lead concentrate and averaging for the last seven years from 5 to 7 fine ounces per ton of lead concentrate. Sphalerite, or zinc blende, is the next important metallic mineral, but it occurs much less plentifully than galena. It is recovered as zinc middlings in the concentration of the fluorspar. The difficulty of making a clean separation of the zinc middlings has kept down the production of zinc. None has been sold from southern Illinois in the last nine years. The principal vein minerals are fluorspar, calcite, and barite.

The shipments of galena concentrates increased from 1,196 tons in 1917 to 1,228 tons in 1918, and the silver content recovered in treating the concentrates increased from 7,186 ounces in 1917 to 8,171 ounces in 1918. The average lead content of the concentrates decreased from 70.7 per cent in 1917 to 70.0 per cent in 1918. The average silver content per ton recovered from lead concentrates increased from 5.80 ounces in 1917 to 6.65 ounces in 1918.

The Fairview Fluorspar & Lead Co., which was much the largest producer of galena, operated on the Good Hope vein, which was first developed in 1862. Most of the ore was obtained between the 200 and 300 foot levels at the Extension mine and between the 300 and 400 foot levels at the Blue Diggings mine. This company also operated the Franklin mine near Marion, Ky.

The Rosiclare Lead & Fluorspar Co. operates on an ore body which is probably continuous with that of the Fairview. The main shaft at the Rosiclare has reached a depth of 520 feet, and the other two shafts operated are 300 and 400 feet deep. The steel and concrete mill, entirely fireproof, is designed to handle 500 tons a day and is provided with special facilities for saving the lead and zinc both by jigs and by tables.

IOWA.

By J. P. Dunlop.

The lead and zinc deposits of Iowa extend along Mississippi River for nearly 80 miles, in Dubuque, Clayton, and Allamakee counties. They are found in the Galena dolomite, of Ordovician age.

In early days the Dubuque mines were the most important source of lead in the United States, and in later years the mines, especially those in the vicinity of Durango, yielded considerable quantities of zinc-carbonate ore.

The ore deposits of the Dubuque district occur in crevices and in caves or "openings" along these crevices. Of these openings there are five or six, the "top," "middle," and "third" being the most prolific of ore. The "flats" and "pitches," common in the Wisconsin mines, have been found in only one or two places in Iowa. The crevices have an east-west trend and sometimes extend considerable distances, being mined at different places, in which case they are known as "ranges."

No shipments of lead or zinc concentrates from mines in Iowa were reported in 1918.

KANSAS.

By J. P. DUNLOP.

PRODUCTION.

Mine production of lead and zinc in Kansas, 1918.[a]

District.	Ores.						Metal content.			
	Lead concentrates.		Zinc concentrates.				Lead.		Zinc.	
	Galena.		Sphalerite.		Carbonate and silicate.					
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Badger-Peacock....	234	$21,192	1,041	$59,999	....	....	186	$26,412	561	$102,102
Lawton-Waco (in Kansas)..........	31	2,730	7,830	459,045	....	....	22	3,124	4,285	779,870
Blue-Mound - Baxter Springs.......	7,625	702,949	40,473	2,138,930	....	....	6,109	867,478	22,041	4,011,462
Galena.............	[b] 1,193	98,832	6,635	279,670	....	....	935	132,770	3,310	602,420
	9,063	825,703	55,979	2,937,644	....	....	7,252	1,029,784	30,197	5,495,854
Total, 1917...	3,929	368,987	38,766	2,673,168	21	$930	3,025	520,300	20,249	4,130,796

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses of zinc but not of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the lead is calculated from the average sales price for all grades and that of zinc in 1917 and 1918 from the average sales price reported by the smelters.

[b] Includes 4 tons of lead carbonate.

Tenor of lead and zinc ore and concentrates produced in Kansas, 1917 and 1918.

	1917	1918
Total crude ore..........short tons..	903,400	1,025,400
Total concentrates in crude ore:		
Lead..........per cent..	0.43	0.88
Zinc..........do....	4.29	5.46
Metal content of crude ore:		
Lead..........do....	.33	.70
Zinc..........do....	2.49	3.27
Average lead content of galena concentrates..........do....	77.0	79.9
Average zinc content of sphalerite concentrates..........do....	58.0	59.9
Average zinc content of zinc silicate and carbonate..........do....	40.0	....
Average value per ton:		
Galena concentrates..........	$93.91	$90.90
Sphalerite concentrates..........	$68.96	$52.48
Zinc silicate and carbonate..........	$44.29	....

The lead and zinc deposits of Kansas, so far as developed, are limited to the southeastern portion of the State, in Cherokee County. They comprise the western extension of the ore deposits of the Joplin region and display the general characteristics of that area, except that here typical sheet-ground deposits have not been extensively developed. The ores are galena and lead carbonate, sphalerite or zinc blende, and zinc carbonate and silicate. The galena is practically nonargentiferous, carrying but a small fraction of an ounce of silver to the ton of lead concentrates.

It is difficult to obtain the production for early years or to segregate the Kansas ores from those produced in the adjoining portion of the Joplin region in Missouri. If to the figures obtained and published by the State Geological Survey of Kansas for the years 1886–1903[1] are added those for the years 1904–1918, published by the United States Geological Survey, a total output of 1,140,226 tons of zinc concentrates and of 162,451 tons of lead concentrates is shown as the approximate production of Kansas for the years 1886–1918, inclusive.

Notwithstanding the fact that in 1918 the older mining camps at Lawton, Galena, and Badger produced only about one-third as much zinc and lead as in 1917, this decrease was more than balanced by the greatly increased production from the Blue Mound-Baxter district, an extension of the Miami field, and by the new Waco camp on the Kansas-Missouri State line.

The value of the mine production of lead and zinc in Kansas in 1918 was $6,525,638, against $4,651,096 in 1917.

The value of the recoverable lead in galena concentrates shipped from Kansas mines in 1918 was $1,029,784, or about double that of 1917. The production of lead concentrates increased from 3,929 tons in 1917 to 9,083 tons in 1918, and the metal content from 3,025 tons to 7,252 tons. The percentage of lead concentrates in crude ore milled increased from 0.43 per cent in 1917 to 0.88 per cent in 1918. This increase was due to the larger recoveries of lead from the new mines near Blue Mound, whose mills treated more than 70 per cent of all the crude ore mined in Kansas in 1918.

The average lead content of the galena concentrates sold was 2.9 per cent more in 1918 than in 1917, and the average price received for such concentrates was $90.90 a ton, against $93.91 in 1917.

The production of sphalerite concentrates in 1918 was 55,979 tons, valued at $2,937,644, an increase of 17,213 tons in quantity and of $264,476 in value, as compared with 1917. The average zinc content of the sphalerite concentrates shipped was 1.9 per cent more in 1918 than in 1917. Owing to the much richer ore mined in the new Waco and Blue Mound districts and to lower ore prices and higher costs of mining, the total per cent of sphalerite concentrates recovered from crude ore treated in Kansas increased from 4.29 per cent in 1917 to 5.46 per cent in 1918.

Badger-Peacock district.—The production of the Badger-Peacock district, including several shipments of galena from some prospects at Pershing, west of Badger, was 234 tons of galena and 1,041 tons of sphalerite, against 99 tons of galena and 2,264 tons of sphalerite in 1917. Nearly all of this output was made by the Joplin Peacock Zinc Corporation, a lessee of the United Zinc Co. In addition to the mining operations conducted at the 160-foot level, there were several lessees working galena ore bodies at upper levels. Two 90-foot shafts were sunk on the Nevada-O'Hara land, near Pershing, from which about a car load of galena was recovered by means of hand jigs. Fifteen drill holes were also sunk, which are said to have located high-grade galena ore between 75 and 105 feet, and sphalerite ore between 105 and 175 feet. A shaft was also sunk by the Pershing Mining Co., and some galena which was recovered in the shaft above the water level was shipped.

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[1] Haworth, Erasmus, and others, History, geography, geology, and metallurgy of Galena-Joplin lead and zinc: Kansas Univ. Geol. Survey, vol. 8, 1904.

The land of the Middlesex Land & Mining Co. was leased to the Badger Mining & Development Co., which erected a 200-ton mill, but the mill was not operated nor the mine unwatered in 1918.

Lawton-Waco district.—Nearly all the output of the Lawton-Waco district in 1918 was from the mines in Kansas, near Waco, as the only producing property at Lawton—the Eastern Lead & Zinc Co.—preferred operating on a small scale to exhausting their ore under prevailing conditions. The total production of the district (including only those mines near Waco in Kansas) was 31 tons of galena and 7,830 tons of sphalerite, as compared with 116 tons of galena and 5,658 tons of sphalerite in 1917. The total output of the Waco district, lying partly in Missouri and partly in Kansas, in 1918, was 250 tons of galena and 13,166 tons of sphalerite, against 99 tons of galena and 3,653 tons of sphalerite in 1917. The mines on the Kansas side which contributed to the shipments of concentrates made in 1918 were Butte-Kansas No. 1, Butte-Kansas No. 2 (old Acme), Waco No. 1, and the Liberal. Butte-Kansas No. 1 is equipped with a 400-ton mill and Butte-Kansas No. 2 with a 150-ton mill. Waco No. 1, owned by the Union Metals Co., is equipped with a 400-ton mill and is worked through two shafts. The Union Metal Co. also has a lease on the Hurlbut land which will be equipped with a concentrating plant. Waco No. 2 mine is located on the Bennett land in Missouri, and was the largest producer in the district in 1918. Five shafts were operated in 1918, and the concentrating plant has a capacity of 500 tons. There are three runs of ore, the first of which is between the 90 and 100 foot levels, the second between the 125 foot and 170 foot levels, and the lower run occurs between the 300 and 350 foot levels. A new 600-foot compressor was added to the equipment in 1918, and shaft No. 1 was sunk to the 300-foot level. The Freehold Oil & Gas Co. built and operated a 150-ton concentrating plant in 1918 at the Liberal mine on the Bennett land in Kansas, and also drilled out and sunk shafts on two prospects on the Missouri side of the line. The large production from the mine in Kansas was from ore hoisted from the 162-foot level, and averaged nearly 9 per cent in sphalerite. The ore taken out during the sinking of shafts at the new mines in Missouri is rich, and two new concentrating plants will be erected to treat this output.

The mine of the Central Lead & Zinc Co. in Missouri was developed in 1918 and a 250-ton mill was erected and operated late in the year. A new 200-ton mill was built at the Blue Rock mine, but the ground was not opened sufficiently to commence milling in 1918. The mill and shaft at the High Five mine (on Missouri side) was completed but not operated in 1918. Ten or fifteen drill rigs were in steady operation in various parts of the Waco camp and practically all the land in the vicinity has been leased. Among the operators drilling, sinking shafts, or building concentrating plants were the Magnolia Lead & Zinc Co., Commonwealth Metal & Development Co., Allegheny Western Mining Co., Danglade & Franks, O. Longacre, Crescent Lead & Zinc Corporation, and the Gilman Mining Co.

Galena district.—The production of lead concentrates in the Galena district in 1918 was 1,193 tons, valued at $98,832, as compared with 2,709 tons, valued at $246,163, in 1917. The shipments of sphalerite concentrates amounted to 6,635 tons, a decrease of 12,160 tons; and, owing to the lower prices paid for zinc concentrates, the total value of the zinc concentrates was $950,055 less in 1918 than in 1917. The metal content of the lead concentrates was 935 tons in 1918, against 2,037 tons in 1917. The average zinc content of sphalerite sold in the Galena district in 1918, according to the reports of the operators, was 55.4 per cent.

Many of the small leases at Galena are not equipped with concentrating plants, and a considerable part of the production milled at customs mills or sold to "chatters." Early in the year most custom mills and chatters were idle, as very little ore was being mined by small lessees. The Monlux mill was torn down and a roasting plant designed to handle the lower-grade high-sulphur ores produced in the Joplin region was put in operation in December. The plant was constructed by R. R. Heap, who also purchased and shipped a considerable quantity of pyrite to sulphuric-acid plants. There were very few transfers of mining property and mining was less active than for many years. Mines, such as the Wayland, Hurry Up, Diplomat, Latawanna, West Virginia, Murphy, and Hartford, which had been large producers of lead and zinc, were closed down during the year and some of the mills were sold. At the end of the year the only plant in steady operation was the Andayer, on the Illinois Lead & Zinc Co.'s land, which was the largest producer of sphalerite in the Galena district in 1918. Two shafts were used in 1918 and the ore mined came from the 76-foot level. The large body of ore mined at a shallow level, which contained about 8 per cent in concentrates, enabled the owners of this mine to operate steadily, notwithstanding the low prices paid for sphalerite. Lessees on the land of the Galena Lead & Zinc Co., Wyandotte Lead & Zinc Co., Playter Mining Co. (South Side), Empire Mining Co., and Templar Mining Co., produced most of the galena and sphalerite sold, although few of the leases were being operated at the end of the year.

Blue Mound-Baxter district.—Although retarded considerably by adverse conditions prevailing in all mining regions, the activity in that part of Cherokee County, Kans., caused by the progressive northerly development of the Miami district, continued throughout 1918. Drilling was not as active as in 1917, but many mining shafts were sunk and mills constructed. Leases were sold for large sums of money, especially north and northwest of Treece. Most of the new mills were not completed until late in 1918 and many were operated only single shift, either because the ground was not sufficiently opened to supply adequate ore or because there was no incentive to exhaust the ore bodies at little or no profit. In fact much of the development was necessary in order to fulfill the terms of the leases. Most of the output in 1918 came from mines situated north and northwest of the Picher area and close to the State line, although several mines north of Hockerville, Okla., and east of Blue Mound produced lead and zinc concentrates in 1918. A number of shafts were sunk west of Baxter Springs and several mills were built or under construction. Large quantities of water slowed up the sinking of shafts near Baxter Springs, but this condition can be overcome by installing sufficient pumps, which will be done as soon as the prospect of higher prices for zinc ore becomes better. The shipments of concentrates which amounted to 1,005 tons of galena and 12,070 tons of sphalerite in 1917, increased to 7,625 tons of galena and 40,473 tons of sphalerite in 1918. The average lead content of the galena sold was more than 80 per cent and the zinc content of the sphalerite concentrates sold was 60.5 per cent. The crude ore (dirt) milled yielded 6.77 per cent in concentrates and at some mines the recovery was more than 10 per cent. Of this production in 1918 all but 8 per cent was shipped by mines west and northwest of Blue Mound. As in 1917, the largest producing mines were the Blue Mound, Blue Diamond, and Barr (Vinegar Hill). These three properties produced more than one-half of the concentrates shipped in 1918.

The Blue Mound mine is equipped with a 300-ton mill and dirt was hoisted from levels between 225 and 284 feet through three shafts. The Mineral Float Co. built a flotation plant having a capacity of 100 tons daily at the Blue Mound mine. The plant treats tailings and has been steadily operated since it was completed in the fall of 1918.

The Blue Diamond mine, lying west of the Blue Mound, also has a 300-ton concentration plant. The Barr mine of the Vinegar Hill Zinc Co. mined ore bodies on the 150, 223, and 300 foot levels, which was hoisted through three shafts and milled at a 350-ton plant. The Webber mine, belonging to the Commerce Mining & Royalty Co., produced very little lead but the output of high-grade sphalerite was large and the crude ore averaged about 10 per cent in concentrates. Companies which developed new mines which produced galena or sphalerite in 1918, with number and depth of shafts used, and capacity of concentrating plants, were as follows: Southern Lead & Zinc Co., two shafts 240 feet deep, mill 500 tons; Early Bird Mining Co., shaft 209 and 235 feet, 350-ton mill; Redskin Mining Co., one shaft 260 feet, mill 350 tons; U. S. Mining & Smelting Co. (Naylor mine), two shafts, mill 350 tons; Kansouri Mining Co., shaft 280 feet, mill 350 tons; De Armond Mining Co., shaft 250 feet, mill 250 tons; Silver Fox Mining Co., two shafts 235 feet, mill 300 tons; Kanoma Mining Co., two shafts 235 feet, mill 200 tons; Rebekah Mining Co., one shaft, mill 150 tons. Properties on which shafts were sunk or mills erected which were not completed or operated in 1918 were the Silver Plume Mining Co., Crescent Lead & Zinc Corp., Big Elk Mining Co., and Brown & Head Mining Co. East of Blue Mound and north of Hockerville the mines from which concentrates were shipped in 1918 were the Federal Mining & Smelting Co. (Lucky O. K.), Queen Esther Mining Co., Lucky Jennie Mining Co., and the Kansas Line Mining Co. Of this group of mines the Lucky O. K. mine, which is equipped with a 250-ton mill and two shafts, was the largest producer. The ore treated was mined at 180 feet by means of two shafts. The property was purchased by the present owners in 1918, and two K. & K. flotation machines and Dorr thickeners and other equipment was added to the surface plant. The Queen Esther was the only other large producer north of Hockerville. Ore was mined on the upper level at 145 feet and the shafts were being sunk in order to take up 25 feet of stope. The 250-ton mill at the Lucky Jennie mine was completed in 1918, but was only in operation about 10 days. A few tons of galena was shipped from the Mississippi

Queen mine and some galena and sphalerite was taken out while sinking a shaft at the Kansas Line mine on a lease of the Chanute Spelter Co. The Chanute Spelter Co. did considerable drilling and sunk shafts on the Ebenstein and Hartley lands, near Baxter Springs. A mill was completed on the Hartley land and shafts were started after the leasehold had been thoroughly drilled. Many other shafts will be sunk and mills built as soon as prices for zinc concentrates warrant the expense involved for construction and pumping.

KENTUCKY.

By J. P. Dunlop.

PRODUCTION.

Lead and zinc deposits are found in both central and western Kentucky. None of the mines in Franklin, Mercer, Scott, Owen, or Henry counties, in the central districts, reported any lead or zinc concentrates shipped in 1918. The mines in the fluorspar region of western Kentucky are chiefly in Crittenden, Caldwell, and Livingston counties and form a continuation of the southern Illinois lead and zinc region. The earliest available records of the occurrence of fluorspar and the associated galena in the Kentucky-Illinois region appeared in the first, second, and third volumes of the American Journal of Science, published in 1818, 1820, and 1821.[1]

The presence of zinc blende was recognized in 1854–1857 during the first geological survey of the State of Kentucky by David Duke Owen and his assistant, Sidney S. Lyon. The first lead smelter using galena from Kentucky was erected by the River Valley Mining Co. at the Royal mine[2] about 1870.

Considerable quantities of galena ores have been produced in former years, but at the present time lead is obtained solely as a by-product in the recovery and concentration of fluorspar, which is the principal economic mineral. The galena recovered is argentiferous, the silver content varying from a very small quantity to more than 3 ounces a ton, but no recovery of this silver content has been reported by the smelters during the last seven years. The lead concentrate shipped in any one year from Kentucky does not necessarily represent the actual recovery of lead from fluorspar mined in that year, for, being merely accessory to the fluorspar and produced in small quantities, it is frequently held until a considerable quantity has accumulated or until lead prices are high.

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[1] Ulrich, E. O., and Smith, W. S. T., The lead, zinc, and fluorspar deposits of western Kentucky: U. S. Geol. Survey Prof. Paper 36, pp. 16–17, 1905.

[2] Fohs, F. J., Fluorspar deposits of Kentucky: Kentucky Geol. Survey Bull. 9, 1907.

Mine production of lead and zinc in Kentucky, 1907–1918.

Year.	Ores.						Metal content.			
	Lead concentrates (galena).		Zinc concentrates.				Lead.		Zinc.	
			Sphalerite.		Zinc carbonate.					
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1918	255	$21,066			927	$30,390	185	$26,270	315	$57,330
1917	184	15,415			2,299	78,368	123	21,156	751	153,204
1916	227	16,868	125	$6,407	2,923	126,875	153	21,114	1,096	293,728
1915	370	17,103			2,172	106,079	251	23,594	764	189,472
1914	26	800	27	1,120	644	12,168	16	1,248	230	23,460
1913	40	1,422	198	5,206	696	13,811	22	1,936	327	36,624
1912	151	6,827	498	25,391	750	16,006	106	9,540	491	67,758
1911					467	10,604			158	18,012
1910	56	1,980			30	300	41	3,608	6	648
1909	12	620			150	1,701	10	800	64	6,912
1908										
1907	54	2,850					34	3,604		

The shipments of zinc carbonate decreased from 2,299 tons, valued at $78,368, in 1917 to 927 tons, valued at $30,390, in 1918. The estimated recoverable zinc content in 1918 was 315 tons, valued at $57,330.

The shipments of galena concentrates reported in 1918 were 255 tons, valued at $21,066, compared with 184 tons, valued at $15,415 in 1917. The average lead content was 72.1 per cent, compared with 66.8 per cent in 1917. The recoverable metallic content of the galena in 1918 was 185 tons, valued at $26,270.

The total value of the lead and zinc concentrates shipped from Kentucky mines was $51,456, as against $93,783 in 1917.

The principal sellers of galena concentrates were the Roberts Fluorspar & Lead Co., the Kentucky Fluorspar Co., J. M. Persons, and the Fairview Fluorspar & Lead Co.

The galena shipped by the Kentucky Fluorspar Co. came from various mines operated by the company. The Franklin mine of the Fairview Fluorspar & Lead Co. produced fluorspar ore containing galena from a 300-foot shaft. The galena shipped by the J. M. Persons Mining Co. was from the mines of the Ohio Valley Fluorspar Co. The Franklin mine of the Fairview Fluorspar & Lead Co. is equipped with a 100-ton mill, and practically all the ore milled was mined at levels between 150 and 300 feet.

The American Spar Co. operated the Hudson mine of the Eagle Fluorspar Co., near Salem, in Livingston County, and shipped most of the zinc carbonate. The ore was taken from workings about 85 feet in depth and treated in log washers before shipment.

Zinc carbonate ore was also mined and shipped from the Masser mines by Avery H. Reed.

MICHIGAN.

By B. S. Butler.

PRODUCTION.

In 1918 the mines of Michigan produced 226,794,139 pounds of copper, valued at $56,018,152, and 509,467 fine ounces of silver, valued at $509,467, a total value in copper and silver of $56,527,619. This was a decrease of $13,848,612 in value from the production of 1917. The average price of copper per pound for 1918 was $0.247; for 1917 it was $0.273. The average price of silver per fine ounce for 1918 was $1; for 1917 it was $0.824. Owing to the decrease in the price of copper, there was a decrease from $5.63 in 1917 to $4.95 in 1918 in the average value of copper per ton of ore or "rock" treated. The smelter production or the output of refined copper for 1918 was 231,096,158 pounds, as compared with 268,508,091 pounds in 1917. The difference between the mine and the smelter production is due to the fact that the quantity of concentrates or "mineral" produced is not the same as the quantity smelted. A company may produce either more or less "mineral" than it smelts during the year.

Production was seriously hampered throughout the year by shortage and inefficiency of labor.

Value of silver and copper produced at Michigan mines in 1917 and 1918.

Year.	Silver.	Copper.		Combined silver and copper.
		Total.	Per ton of ore or "rock."	
1917	$567,366	$69,808,865	$5.63	$70,376,231
1918	509,467	56,018,152	4.95	56,527,619
Decrease	57,899	13,790,713	.68	13,848,612

Mine production of silver, copper, concentrates or "mineral" and ore or "rock" in Michigan in 1917 and 1918.

Year.	Silver (fine ounces).	Copper.			Concentrates ("mineral").		Ore ("rock") (short tons).
		Quantity (pounds).	Yield.		Quantity (pounds).	Yield (per cent).	
			Pounds per ton of ore ("rock").	Per cent.			
1917	688,551	[a] 255,710,128	19.9	.99	[b] 410,262,995	62.33	12,400,723
1918	509,467	[a] 226,794,139	19.2	.96	[b] 364,837,334	62.16	11,321,365
Decrease	179,084	28,915,989	0.7	.03	45,425,661	.17	1,079,358

[a] Includes copper from sands.

[b] Includes "mineral" from sands.

The entire Michigan output of copper and silver is from the Keweenaw district. Both metals occur native in lodes remarkable for their great extent and uniformity. These lodes may be divided into two general classes—the amygdaloid, in which the metals occur together with gangue minerals, such as epidote, calcite, and zeolites, in the cellular portions of lava flows; and the conglomerate, in which the metals and gangue minerals cement and to some extent replace the pebbles forming the conglomerate. Native copper and copper minerals occur in fissures in the district, but the present output from this type of deposit is of little importance. The ore ("rock")[1] is of low grade and requires milling, which produces concentrate ("mineral") carrying an average of about 65 per cent copper. A small quantity of " barrel " and " mass " copper is sorted at the mines and sent direct to the smelters.

In 1918 there were 11,321,365 short tons of ore (" rock ") milled, which yielded 364,837,334 pounds of concentrate (" mineral ") and 226,794,139 pounds of copper.[2]

The average recovery of refined copper per ton of ore (" rock ") milled in 1918 was 19.2 pounds, as compared with 19.9 pounds in 1917.

There were 509,467 ounces of silver derived from the electrolytic treatment of 56,127,000 pounds of copper.

Three counties—Houghton, Keweenaw, and Ontonagon—contributed to the output of copper and silver. The following table shows the relative importance of these counties in output of copper and silver for 1917 and 1918:

Mine production of silver and copper in Michigan in 1917 and 1918, by counties.

County.	Silver (fine ounces).	Copper.			Concentrate ("mineral").		Ore ("rock") (short tons).
		Quantity (pounds).	Yield.		Quantity (pounds).	Yield (per cent).	
			Pounds per ton of ore ("rock").	Per cent.			
1917.							
Houghton	558,465	[a] 195,446,231	21.0	1.05	[b] 320,257,671	61.0	9,297,322
Keweenaw	62,581	49,126,614	20.1	1.00	72,839,079	67.4	2,443,551
Ontonagon	67,505	11,137,283	16.9	.84	17,166,245	64.9	659,850
Total and average	688,551	255,710,128	19.9	.99	410,262,995	62.3	12,400,723
1918.							
Houghton	453,957	[a] 173,371,829	19.1	.95	[b] 283,854,508	61.1	8,604,767
Keweenaw	9,323	42,703,494	19.7	.98	64,110,463	66.6	2,165,722
Ontonagon	46,187	10,718,816	19.5	.97	16,872,363	63.5	550,876
Total and average	509,467	226,794,139	19.2	.96	364,837,334	62.2	11,321,365

[a] Includes copper from sands.

[b] Includes "mineral" from sands.

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[1] Some of the terms used to designate the different materials entering into the mining industry differ for the Lake district from those employed in any other part of the country. Ore is known as " rock," or (if unmined) " coppper ground " ; the product of concentration is known as " mineral " ; and the term " ore " is used to designate the copper minerals (arsenides and sulphides) that occur to a limited extent in the district. Large bodies of native copper are known as " mass " and smaller ones are designated as " barrel work." In this report the local terms will be used, as it does not seem desirable to employ the more usual terms to the exclusion of the local, and a mixture of the two is confusing.

[2] The figures are based on the actual recovery of copper from " mineral " smelted and the estimated recovery from " mineral " that was not smelted during 1916.

In the following reviews of the operations at the individual mines of the district during 1918, the statements concerning the quantity, character, and tenor of "rock" developed, the quantity of "rock" stamped, the copper recovered per short ton of "rock" stamped, and the cost of production are based on the published reports of the companies. In the few cases in which reports are not published a general statement of the character of operations is made from the best information available.

HOUGHTON COUNTY.

In 1918 the mines of Houghton County produced 173,371,829 pounds of copper and 453,957 ounces of silver. The county occupies the central portion of the copper belt and contains 14 of the 22 mines that produced copper in 1918 and 5 of the 7 mines that produced silver.

Ore—"rock"—and concentrate—"mineral"—produced and average yield in silver and copper in Houghton County in 1917 and 1918.

Year.	Silver (fine ounces).	Copper.			Concentrates ("mineral").		Ore ("rock") (short tons).
		Quantity (pounds).	Yield.		Quantity (pounds).	Yield (per cent).	
			Pounds per ton of ore ("rock").	Per cent.			
1917	558,465	[a] 195,446,231	21.0	1.05	[b] 320,257,671	61.0	9,297,322
1918	453,957	[b] 173,371,829	19.1	.95	[b] 283,854,508	61.1	8,604,767

[a] Includes copper from sands.

[b] Includes "mineral" from sands.

The output of the county shows a decrease of 22,074,402 pounds of copper and of 104,508 fine ounces of silver for 1918.

Calumet & Hecla.—The Calumet & Hecla Mining Co. has been one of the most successful copper-mining companies in the world. To the end of 1918 the company had distributed $150,750,000 in dividends.

The company's ground contains three copper-bearing lodes—the Calumet & Helca conglomerate, the Osceola amygdaloid, and the "Kearsarge" amygdaloid. A large percentage of the production in the past has come from the conglomerate lode, but with the decrease in copper content of this lode and its approaching exhaustion, the mining from the amygdaloid lodes has increased.

The company's annual report shows the details of operation for 1918 as follows:

During 1918 there were 2,876,392 short tons of "rock" treated, yielding 58,722,969 pounds of copper, or an average of 20.42 pounds of copper per ton of "rock." This compares with a yield of 21.65 pounds for 1917. The total cost per pound of copper was 21.05 cents for 1918, including 5.34 cents per pound for depreciation and depletion. The recovery of copper from old sands added to the recovery from "rock" made a total production of 67,968,357 pounds.

In 1918 the conglomerate lode produced 1,547,603 tons of "rock," yielding 43,329,816 pounds of copper, or an average of 28.00 pounds per ton of "rock," as compared with 28.78 pounds for 1917.

The Osceola lode has an average width of 30 to 35 feet, though at some points it is much wider. The mineralization is confirmed principally to the hanging walls and the footwalls. The lode is opened by drift stopes along the hanging wall, where the mineralization is rather uniform. Crosscuts are extended to the footwall, where the mineralization is far less regular. In 1918 this lode produced 1,328,789 tons of "rock," yielding 15,393,153 pounds of copper, or 11.58 pounds per ton of "rock." This compares with a yield of 12.79 pounds per ton of "rock" for 1917.

Development on the Kearsarge lode in Calumet & Hecla ground has not been encouraging, though the lode has proved very productive farther north. There was no output from the Kearsarge lode in 1918.

The reclamation plant for treating old tailings from Torch Lake treated 715,007 tons, having an average copper content of 17.36 pounds per ton. A total of 9,245,388 pounds of copper was recovered, or an average of 12.93 pounds per ton, at an average cost, exclusive of smelting and selling, of 7.20 cents per pound.

The following tables show the operations of the regrinding plant and the leaching plant:

Summary of operations of regrinding plant, Calumet & Hecla Mining Co., for the year 1918.

	From mine.	From old sands.
Tons treated	530,657	715,007
Assay headings	0.599	0.868
Assay tailings	0.414	0.568
Pounds refined copper	2,243,022	4,776,302
Pounds refined copper per ton treated	4.23	6.68
Cost per pound, excluding smelting and selling ..cents..	6.75	4.33

Summary of operations of leaching plant, Calumet & Hecla Mining Co., for the year 1918.

Ore treated	short tons	1,005,015
Assay of headings	per cent	0.535
Assay of tailings	do	0.126
Refined copper	pounds	8,035,156
Refined copper per ton treated	do	8.00
Cost per pound of copper, excluding smelting and selling	cents	7.71

Osceola.—In 1918 the Osceola Co. operated the three branches—the Osceola, the South Kearsarge, and the North Kearsarge. Since 1878 this company has distributed dividends to the amount of $17,371,775.

The Osceola branch lies directly south of the Calumet & Hecla and is worked on the Osceola amygdaloid. The property contains the Calumet & Hecla conglomorate lode, but the only portion of it in Osceola ground that has been shown to carry copper in paying quantities was worked out in the early days of the mine.

A total of 230,517 tons of "rock" was produced in 1918, yielding 3,252,233 pounds of copper or an average of 14.11 pounds per ton.

The North Kearsarge lies north of the Wolverine and is worked on the Kearsarge lode. This branch produced 745,722 tons of "rock," yielding 9,395,968 pounds of copper, or an average of 12.60 pounds per ton.

The South Kearsarge lies south of the Wolverine and east of the Centennial on the Kearsarge lode.

This branch produced 218,728 tons of "rock," yielding 3,271,446 pounds of copper, or an average of 14.96 pounds per ton.

In 1918 the company treated 1,194,967 tons of "rock," producing 15,919,647 pounds of copper, an average yield of 13.3 pounds of refined copper per ton of "rock." This compares with a yield of 13.0 pounds in 1917. The total cost of refined copper per pound was 17.67 cents for 1918, including 3.07 cents per pound for depreciation and depletion.

Dividends were declared in 1918 to the amount of $961,500.

Centennial.—The Centennial ground lies north of the Calumet & Hecla and west of the South Kearsarge and the Wolverine. It contains the Calumet & Hecla, the Osceola, and the Kearsarge lodes, the last being the only one of proved value in the property, and to this lode operations are at present confined.

"Rock" to the amount of 159,040 tons was stamped during the year, producing 2,492,857 pounds of refined copper or 15.67 pounds of refined copper per ton of "rock" stamped. The average cost of refined copper per pound was 18.65 cents, which includes 2.95 cents per pound for depreciation and depletion.

Dividends were paid during the year to the amount of $180,000.

Wolverine.—The Wolverine is located between the North Kearsarge and the South Kearsarge branches of the Osceola Co. Its operations are on the "Kearsarge" amygdaloid, though the West lode, parallel with the Kearsarge lode and about 80 feet to the west, has been opened to a small extent. The mine has the distinction of having the richest rock mined in the district. The operations on the Osceola lode have thus far proved disappointing. The Kearsarge lode in the Wolverine ground shows great uniformity of mineralization and is opened for the full length. In the upper levels the "rock" averaged from 16 to 18 pounds per ton, but as the lower levels were opened it showed marked improvement. As the bottom limits are approached there is a notable decrease in the copper content of the rock.

During the fiscal year ending June 30, 1918, there were stamped 303,498 tons of "rock," which produced 6,961,500 pounds of "mineral," yielding 4,608,865 pounds of copper, or 15.185 pounds of refined copper per ton of "rock" stamped. The total cost per pound of refined copper was 18.927 cents, including 3.712 cents for depletion and depreciation.

Since its organization to June 30, 1918, the company has produced 161,148,835 pounds of copper. Operations have resulted in profits amounting to $10,985,713, of which $10,110,000 has been paid in dividends. Three dividends paid during the fiscal year amounted to $570,000.

Franklin.—The Franklin and the Rhode Island, which is controlled by the Franklin, are located southeast of the La Salle. The property carries several lodes, but in the past exploration has been principally on the "Pewabic" amygdaloid and the Allouez or "Albany and Boston" conglomerate.

Of the "rock" produced in 1918, 24.6 per cent came from the "Pewabic" amygdaloid and 75.4 per cent from the Allouez conglomerate.

Quincy.—The Quincy mine is situated just north of the eastern arm of Portage Lake. The property is traversed by most of the lodes of the district, but has derived its principal output in the past from the Pewabic lode, with a small quantity from the West lode.

Dividends to the amount of $935,000 were paid in 1918. Total disbursement in dividends from 1862 to 1918 is $26,452,500.

In 1918 there were mined 1,174,147 tons of "rock," which yielded 31,970,969 pounds of "mineral" and 19,948,965 pounds of copper, an average of 16.99 pounds per ton of rock.

Isle Royale.—The Isle Royale mine is situated south of the eastern arm of Portage Lake, near Houghton. The property contains several copper-bearing lodes, of which the Isle Royale is the main producer at present.

During 1918 "rock" amounting to 974,508 tons was treated, yielding 15,442,508 pounds of copper, or an average of 15.9 pounds of copper per ton. The average cost per pound of copper was 16.51 cents, including 1.44 cents per pound for depreciation and depletion.

Dividends were paid to the amount of $375,000.

Baltic, Champion, and Trimountain.—These three mines are located on the Baltic lode southwest of Houghton and are under the management of the Copper Range Consolidated Co. The Baltic is an exceptionally strong lode, having a stoping width varying from 15 to 80 feet. The lode has produced considerable "mass" copper and also contains veinlets of copper minerals, including chalcocite, bornite, and copper arsenides. These minerals are recovered in the mill, and the arsenides probably account in part for the arsenical character of the Copper Range output.

During 1918 a total of 293,601 tons of "rock" from the Baltic mine was stamped, producing 10,406,097 pounds of refined copper, or 34.44 pounds of refined copper per ton of "rock" stamped. The cost per pound of refined copper was 15.07 cents.

A total of 201,433 tons of "rock" from the Trimountain was stamped, yielding 5,343,586 pounds of refined copper, or an average of 26.52 pounds per ton. The average cost per pound of copper was 18.42 cents.

Since its organization the company has produced 122,151,711 pounds of copper at a profit of $5,077,821, of which $1,950,000 has been disbursed as dividends.

The Champion Copper Co. is controlled jointly by the Copper Range Consolidated Co. and the St. Mary's Mineral Land Co. A total of 594,235 tons of "rock" was stamped, yielding 21,748,514 pounds of refined copper, a yield of 36.599 pounds per ton of "rock" stamped. The cost of refined copper per pound was 11.92 cents.

From its organization to the close of 1918 the Champion Co. has produced 308,172,067 pounds of copper at a profit of $26,050,023, of which $23,970,260 has been disbursed as dividends.

Superior.—During the year 106,213 tons of "rock" from the Superior was stamped, producing 1,676,446 pounds of copper, or 15.78 pounds per ton of "rock" stamped. The cost of copper a pound was 25.06 cents, including 5.78 cents per pound for depletion and depreciation.

La Salle.—The La Salle Co. produced 176,423 tons of "rock" yielding 1,832,665 pounds of copper, or an average of 10.388 pounds per ton of "rock." The net cost per pound of copper was 21.81 cents, including 1.25 cents per pound for depreciation.

Winona.—From January to May the lessee produced 756,826 pounds of copper. For the rest of the year the company produced 57,837 tons of "rock," which yielded 1,359,055 pounds of "mineral" and 819,857 pounds of refined copper, an average of 14.157 pounds of refined copper per ton of "rock" stamped.

The total production for the year was 1,576,683 pounds.

Hancock.—The Hancock Consolidated Mining Co. treated 227,049 tons of "rock," which yielded 3,041,514 pounds of refined copper, an average of 13.40 pounds per ton.

New Arcadian.—The New Arcadian Copper Co. shipped 10,195 tons of "rock," yielding 164,794 pounds of refined copper. Operations were suspended at the mine in September on account of the shortage of labor.

Houghton.—Development was continued until August, when operations were suspended.

Other companies.—Other companies were active in development work.

KEWEENAW COUNTY.

In 1918 Keweenaw County produced 42,703,494 pounds of copper and 9,323 fine ounces of silver. The county occupies the northern portion of the copper belt.

Ore ("rock") and concentrate ("mineral") produced and average yield in silver and copper in Keweenaw County in 1917 and 1918.

Year.	Silver (fine ounces).	Copper.			Concentrate ("mineral").		Ore ("rock") (short tons).
		Quantity (pounds).	Yield.		Quantity (pounds).	Yield (per cent).	
			Pounds per ton of ore ("rock").	Per cent.			
1917	62,581	49,126,614	20.1	1.00	72,839,079	67.4	2,443,551
1918	9,323	42,703,494	19.7	.98	64,110,463	66.6	2,165,722

Ahmeek.—The Ahmeek mine, lying north and east of the Allouez, is located on the Kearsarge lode.

A total of 1,196,541 tons of "rock" were stamped, yielding 24,851,235 pounds of refined copper, or 20.8 pounds of refined copper per ton of "rock." The total cost per pound of refined copper was 14.30 cents, including 2.52 cents per pound for depreciation and depletion.

During the year dividends were declared to the amount of $1,600,000. Total dividends to the close of 1918 amounted to $11,250,000.

Allouez.—The Allouez mine is north of the North Kearsarge. In 1918, as in recent years, operations were confined to the Kearsarge lode. As this lode does not outcrop on Allouez property the shafts were started in the hanging wall at a steep angle and flattened to the dip of the copper-bearing bed just before reaching it. This plan avoids the expense of long crosscuts necessitated by vertical shafts.

A total of 514,888 tons of "rock" was stamped during 1918, yielding 7,071,218 pounds of refined copper, an average of 13.73 pounds of refined copper per ton of "rock." The total cost per pound of refined copper was 19.73 cents, including 2.81 cents per pound for depletion and depreciation.

Dividends declared during the year amounted to $600,000. Total dividends to April, 1919, amounted to $2,850,000.

Mohawk.—The Mohawk mine, lying east of the Ahmeek, carries the outcrop of the Kearsarge lode for more than a mile and also contains several cross fissures carrying arsenides of copper, which have been mined to a considerable extent.

A total of 454,293 tons of "rock" were stamped, yielding 15,011,000 pounds of "mineral," and 10,781,041 pounds of copper, or an average of 23.73 pounds per ton of "rock." The total cost per pound of refined copper was 14.64 cents.

Since organization the Mohawk Co. has produced 170,235,843 pounds of copper, at a profit of $10,833,397, of which amount $8,625,000 has been disbursed as dividends. Dividends of $1,000,000 were paid in 1918.

The company estimates that the mine contains 260,738,612 pounds of unmined copper.

ONTONAGON COUNTY.

In 1918, Ontonagon County produced 10,718,816 pounds of copper. Ontonagon County contains the southwestern portion of the copper belt. This portion has not been so thoroughly developed as the others and consequently the geology is less understood than in the more northern counties. So far as developed, the lodes are more "bunchy" than to the north and have produced a relatively high percentage of mass copper. The production of 1918 was derived wholly from amygdaloid rock.

Ore ("rock") and concentrate ("mineral") produced and average yield in silver and copper in Ontonagon County in 1917 and 1918.

Year.	Silver (fine ounces).	Copper.			Concentrate ("mineral").		Ore ("rock") (short tons).
		Quantity (pounds).	Yield.		Quantity (pounds).	Yield (per cent).	
			Pounds per ton of ore ("rock").	Per cent.			
1917	67,505	11,137,283	16.9	.84	17,166,245	64.9	659,850
1918	46,187	10,718,816	19.5	.97	16,872,363	63.5	550,876

Mass.—The Mass mine adjoining the Adventure on the southwest, carries six known copper-bearing amygdaloid lodes—the Knowlton, the Mass, the North Butler, the Butler, the Ogima, and the Evergreen. In addition, the position of the property makes it probable that the newly discovered lodes in this part of the district may be present in Mass ground. The production for the year was from the main Butler lode and branches, the Evergreen lode, and the Ogima lode.

A total of 196,456 tons of "rock" was stamped in 1918, yielding 5,509,130 pounds of "mineral" and 3,403,827 pounds of refined copper, an average of 17.33 pounds of refined copper per ton of "rock" stamped. The average cost per pound of refined copper was 23.82 cents.

Victoria.—The Victoria is the most southwesterly of the Lake mines that have made large production. The present production is from the Forest lode. "Rock" amounting to 106,730 tons was stamped, yielding 2,451,413 pounds of "mineral" and 1,533,536 pounds of copper.

White Pine.—The White Pine Copper Co. treated 194,568 tons of "rock," yielding 3,273,680 pounds of copper at a cost per pound of 24.27 cents, including 2.64 cents per pound for depreciation and depletion.

The Lake mine produced 717,403 pounds of copper in 1918.

The Michigan Copper Co. produced 40,865 tons of "rock," which with "mass" and "barrel" copper yielded 1,177,176 pounds of copper. Developments during the year were very encouraging.

The Adventure Consolidated Copper Co. mine was not operated during 1918.

The mine of the South Lake Mining Co. was operated until July, when it was closed. A total of 7,694 tons of "rock" was stamped, yielding 226,141 pounds of refined copper, or an average of 28.09 pounds per ton.

Exploration and development was conducted by other companies, but on a limited scale on account of the scarcity of labor and the high cost of materials.

MISSOURI.

By J. P. DUNLOP.

PRODUCTION.

VALUE.

The value of the mine production of recoverable silver, copper, lead, and zinc in Missouri in 1918 was $37,953,016, compared with $67,540,500 in 1917. The value of the copper production showed an increase of $43,034, and that of lead decreased $12,701,982. The value of the silver decreased $3,808, and that of zinc decreased $16,924,728, so that 57 per cent of the large decrease in the total value was caused by the smaller production and the lower average price of zinc in 1918, compared with 1917. The recoverable lead content of Missouri lead concentrates sold in 1918 was equal to 36 per cent of the smelter production of primary lead in the United States derived from domestic ores, and the recoverable zinc content from

Missouri zinc concentrates sold in 1918 was 11.4 per cent of the primary zinc produced by smelters from domestic ores in 1918, as against 22.7 per cent in 1917.

Mine production of silver and copper in Missouri, 1910–1918.

Year.	Copper.		Silver.		Lead concentrates, silver bearing (short tons).
	Quantity (pounds).	Value.	Quantity (fine ounces).	Value.	
1910	94,452	$11,955	33,096	$17,872	35,002
1911	640,411	80,051	49,867	26,430	51,109
1912	440,725	72,719	35,438	21,794	31,183
1913	576,204	89,312	35,620	21,514	35,854
1914	44,463	5,914	61,168	33,826	61,995
1915	402,160	70,378	57,756	29,282	64,377
1916	386,200	95,005	129,450	85,178	88,081
1917	365,013	99,649	61,586	50,747	76,222
1918	577,665	142,683	[a] 46,939	46,939	52,000

[a] 7,892 ounces of silver from copper ore or copper concentrates smelted.

For several years prior to 1913 the entire production of silver in Missouri had been derived from refining lead concentrates, but in each of the last six years a small quantity of silver has been obtained from oxidized copper ore shipped from mines in Ste. Genevieve, Washington, and other counties. The quantities given in the fourth column of the foregoing table are those of recovered silver. The silver content of the lead ores is so small that it is disregarded in the assay and sale of the concentrates. For this reason the smelter reports must be relied on for the silver production. As may be seen by inspection of the table, the quantity of silver produced in any year bears no direct ratio to the quantity of lead concentrates smelted during that year. The reason for this is that the silver content is so small in quantity that the silver bullion is stored and refined in batches. If a series of years be taken into account, the concentrates are seen to average less than 1 ounce of silver to the ton.

The production of copper in Missouri in 1918 was 577,665 pounds, valued at $142,683, as compared with 365,013 pounds, valued at $99,649, in 1917. The North American mine, now owned by the Missouri Cobalt Co., which produced some copper as well as nickel and cobalt in the years 1908 and 1909, produced most of the copper in 1918. The remainder of the copper output for 1918 was derived from concentrates recovered in dressing lead ore mined in St. Francois County, in southeastern Missouri, and from a small quantity of copper ore mined and shipped from the Racola mine in Washington County. About 7,900 ounces of the silver reported from Missouri in 1918 was derived from copper concentrates and crude copper ores.

LEAD AND ZINC.

The total value of the recoverable metallic content of the lead and zinc concentrates produced in Missouri in 1918 was $37,763,394, a decrease of $29,626,710 from that of 1917. The production of lead concentrates in Missouri in 1918 (of which all but 9 tons was galena) was 287,983 short tons, valued at $21,988,567, as compared with an output of 345,513 tons, valued at $34,038,976, in 1917, a decrease of 57,530 tons in quantity and of $12,050,409 in value. Of this production in 1918 of lead concentrates 271,506 tons, valued at $20,507,064, was derived from southeastern and central Missouri, a decrease of 34,967 tons in quantity and of $9,563,931 in value. The average metal content of the lead concentrates from these districts was 66.8 per cent, as compared with 66.7 per cent in 1917, and the value per ton in 1918 was $75.53. The quantity of recoverable lead in southeastern and central Missouri concentrates in 1918 amounted to 181,392 tons, a decrease of 23,153 tons. The output was equal to about 33.6 per cent of the primary lead smelted or refined from domestic ores in the United States in 1918.

Shipments of lead concentrates from southwestern Missouri were 16,468 tons, valued at $1,480,910, as compared with 39,040 tons, valued at $3,967,981, in 1917. The lead carbonate concentrates amounted to 9 tons, valued at $593, a decrease of 385 tons. The quantity of recoverable lead from southwestern Missouri, or the Joplin region, was 12,783 tons, valued at $1,815,186, a decrease of 16,828 tons. The average metal content of the galena concentrates from southwestern Missouri was 77.4 per cent, and the average price per ton was $89.91, or $11.99 less per ton than in 1917.

The quantity of zinc blende concentrates sold from Missouri mines in 1918 was 95,555 tons, valued at $4,899,347, a decrease of 136,033 tons in quantity and of $11,554,282 in value, when compared with the figures for 1917. All the blende concentrate, except 13 tons, was produced in southwestern Missouri. The average price received per ton was $51.27, and the average recoverable zinc content reported by the sellers was 58.2 per cent. The average price paid per ton in 1917 was $71.04 and the average recoverable zinc content was 58.5 per cent.

The zinc content of the sphalerite concentrates derived from "sheet ground" mines, which was 58.6 per cent in the years 1911 and 1912, declined to 58.3 per cent in 1913, increased to 58.4 per cent in 1914, to 59.1 per cent in 1915, and to 59.2 per cent in 1916, and decreased to 58.6 per cent in 1917, and to 57.7 per cent in 1918. The average price received for all sphalerite concentrates in 1918 was $22.91 a ton less than in 1917.

The zinc carbonate and silicate concentrates sold in 1918 amounted to 17,816 tons, valued at $574,136. This was 13,170 tons less in quantity and $680,839 less in value than the sales in 1917. The output in 1918 was mainly from southwestern Missouri, the shipments from southeastern and central Missouri being only 235 tons, valued at $6,845 as compared with 293 tons, valued at $7,145, in 1917. The average metal content of the zinc carbonate and silicate concentrates was 37.1 per cent in 1918. The average value per ton in 1918 was $32.23 as compared with $40.50 in 1917.

The combined value of lead and zinc concentrates from southeastern and central Missouri in 1918 (which produced about 94 per cent of the lead concentrates) was $20,514,194, or $9,580,290 less than in 1917.

The total value of the southwestern Missouri lead and zinc concentrates was $6,947,856, as compared with $21,653,096 in 1917, a decrease of $14,705,240.

The total quantity of crude ore or "dirt" mined and treated in 1918 amounted to 9,146,800 short tons, a decrease of about 7,877,000 tons, or approximately 46 per cent less than the quantity mined and treated in 1917. As the total amount received for all classes of lead and zinc concentrates sold in 1918 was $27,462,050 the average value per ton of crude ore or "dirt" mined and treated was $3, as compared with $3.04 in 1917, $2.60 in 1916, $2.20 in 1915, $1.65 in 1914, $1.72 in 1913, and $1.86 in 1912.

The small quantity of copper ore mined and shipped in 1918 is excluded from these calculations.

In the following tables showing the tenor of crude ore ("dirt") and concentrates from Missouri it has been considered advisable to segregate the ores of different nature. For instance, the desseminated lead ore of southeastern Missouri differs radically from the lead and zinc ores of the so-called "soft ground" deposits of southwestern Missouri, and these in turn differ from the "sheet ground" deposits of the same region. Each class of ore has its peculiar problems of mining and ore dressing. This fact makes desirable the separate treatment of the statistical data. In general, the tables reflect very closely the conditions of the industry.

Mine production of lead and zinc in Missouri in 1918.

District.	Lead concentrates.				Zinc concentrates.			
	Galena.		Carbonate.		Sphalerite.		Silicate and carbonate.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons),	Value.
Southwestern Missouri:								
Alba-Neck City	4	$342			2,931	$144,218		
Ash Grove-Everton							58	$1,620
Aurora	56	4,030	4	$320	891	38,427	2,049	60,760
Carl Junction and Waco (Mo.)	257	23,223			5,398	324,389		
Carthage	64	5,729			6,517	399,070	11	236
Cave Springs	47	3,851			1,237	63,690		
Duenweg-Porto Rico	2,152	186,400	5	863	13,983	680,960	2,431	82,267
Granby-Diamond	387	30,133			5,171	266,656	11,737	381,781
Joplin	2,117	181,240			17,025	919,891	741	23,113
McDowell and Stark City	8	853			19	765		
Oronogo	1,618	143,903			7,439	342,998		
Sarcoxie-Reeds					1,155	72,750	120	3,600
Sherwood-Thoms station	22	1,913			942	57,331		
Spring City-Beef Branch	95	6,839					304	9,889
Springfield	186	17,214			452	22,738		
Spurgeon-Seneca	95	8,065			957	48,796	195	3,225
Webb City-Carterville-Prosperity	9,292	861,277			27,210	1,307,797		
Wentworth-Pierce City					3,110	150,765		
Zincite-Klondike	50	4,298			1,068	56,021		
Christian and Wright counties	18	1,600			37	1,800	25	800
	16,468	1,180,910	9	593	95,542	4,899,062	17,581	567,291
Central and southeastern Missouri	271,506	20,507,064			13	285	235	6,845
State total, 1918	287,974	21,987,974	9	593	95,555	4,899,347	17,816	574,136
1917	345,119	34,008,889	394	30,087	231,588	16,453,629	30,986	1,254,975

Mine production of lead and zinc in Missouri in 1918—Continued.

District.	Metal content.[a]			
	Lead.		Zinc.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Southwestern Missouri:				
Alba-Neck City	3	$426	1,532	$278,824
Ash Grove-Everton			18	3,276
Aurora	45	6,390	1,146	208,572
Carl Junction and Waco (Mo.)	203	28,826	2,952	537,264
Carthage	49	6,958	3,584	652,288
Cave Springs	34	4,828	634	115,388
Duenweg-Porto Rico	1,616	229,472	8,129	1,479,478
Granby-Diamond	294	41,748	6,509	1,184,638
Joplin	1,635	232,170	9,287	1,690,234
McDowell and Stark City	6	852	9	1,638
Oronogo	1,260	178,920	3,826	696,332
Sarcoxie-Reeds			689	125,398
Sherwood-Thoms station	17	2,414	508	92,456
Spring City-Beef Branch	74	10,508	109	19,838
Springfield	152	21,574	250	45,500
Spurgeon-Seneca	74	10,508	535	97,370
Webb City-Carterville-Prosperity	7,268	1,032,056	14,031	2,553,642
Wentworth-Pierce City			1,567	285,194
Zincite-Klondike	39	5,538	575	104,650
Christian and Wright counties	14	1,988	28	5,096
	12,783	1,815,186	55,918	10,177,076
Central and southeastern Missouri	181,392	25,757,664	74	13,468
State total, 1918	194,175	27,572,850	55,992	10,190,544
1917	234,156	40,274,832	132,918	27,115,272

[a] In calculating the metal content of the ores from assays allowances has been made for smelting losses in zinc but not in lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead is calculated from the average sales price (all grades), and the value of the zinc from the average sales price of all grades reported by smelters.

Tenor of crude lead and zinc ore and concentrates produced in southwestern Missouri in 1916, 1917, and 1918.[a]

	1916	1917	1918
SOFT GROUND.			
Total crude ore ... short tons	4,711,700	3,447,850	1,710,900
Total concentrates in crude ore:			
Lead ... per cent	0.28	0.33	0.41
Zinc ... do	3.10	3.71	4.30
Metal content of crude ore:			
Lead ... do	.22	.25	.32
Zinc ... do	1.70	1.99	2.30
Average lead content of galena concentrates ... do	78.0	76.1	77.4
Average lead content of lead carbonate concentrates ... do	55.5	62.2	55.5
Average zinc content of sphalerite concentrates ... do	58.1	58.3	58.6
Average zinc content of silicates and carbonates ... do	39.4	39.7	37.1
Average value per ton:			
Galena concentrates	$82.09	$97.94	$87.35
Lead carbonate concentrates	$61.48	$76.36	$65.88
Sphalerite concentrates	$77.94	$69.50	$52.71
Zinc silicates and carbonates	$50.21	$40.50	$32.23
SHEET GROUND.			
Total crude ore ... short tons	8,484,700	7,688,250	1,903,300
Total concentrates in crude ore:			
Lead ... per cent	0.33	0.36	0.51
Zinc ... do	1.86	1.75	2.10
Metal content of crude ore:			
Lead ... do	.25	.28	.41
Zinc ... do	1.10	1.03	1.21
Average lead content of galena concentrates ... do	76.5	75.9	77.4
Average content of sphalerite concentrates ... do	59.2	58.6	57.7
Average value per ton:			
Galena concentrates	$85.62	$103.51	$91.32
Sphalerite concentrates	$86.02	$72.16	$49.25

[a] Including also the small production of lead and zinc ores in southeastern and central Missouri.

Tenor of crude lead ore and concentrates in southeastern Missouri disseminated lead ore in 1916, 1917, and 1918.

	1916	1917	1918
Total crude lead ore .... short tons..	5,467,500	5,887,900	5,532,600
Galena concentrates in crude ore .... per cent..	5.60	5.03	5.01
Lead content in crude ore .... do....	3.68	3.47	3.39
Average lead content of galena concentrates .... do....	65.66	66.7	66.8
Average value per ton of galena concentrates	$67.47	$98.01	$75.53

In Mineral Resources for 1914, Part I, pages 72–77 and 97–100, was given a brief history of lead and zinc mining in the southeastern Missouri and Joplin regions, together with data relating to the total lead and zinc production, the mining and milling practice, and the methods of selling ore and concentrates. The separate chapter entitled "Silver, copper, and zinc in the Central States in 1914" is available for distribution and can be obtained upon application to the Director, United States Geological Survey, Washington, D. C.

In order to expedite the prompt publication and distribution of this report much of the data relating to individual properties as given in previous reports under the reviews by districts has been omitted. All the essential data relating to the districts are included in the yearly State review of the regions.

SOUTHWESTERN MISSOURI.

AREA, ORES, DEPOSITS.

The southwestern Missouri lead and zinc areas includes the largest part of the Joplin region, the remaining portion lying in southeastern Kansas and in northeastern Oklahoma. The Missouri part of the region was first developed, then that in Kansas, followed at a considerably later period by that in Oklahoma.

The ore in southwestern Missouri occurs in the Mississippian Boone limestone, in beds of Kinderhook age. The ore deposits are found in Jasper, Newton, Lawrence, Greene, and adjoining counties. This area produced in 1918 only 34 per cent of the crude lead and zinc ore mined in the Joplin region, compared with 56 per cent in 1917 and 78 per cent in 1916.

The lead ores are galena, with a small quantity of lead carbonate, locally known as "dry bone." The zinc ores are sphalerite or zinc blende, or "jack," zinc carbonate (smithsonite), and zinc silicate (calamine), both of the latter locally called "silicate." The galena contains but a small fraction of an ounce of silver to the ton of lead concentrates, and although ordinarily it is not desilverized, yet occasionally the refineries find it advantageous to add lead from the Joplin region to their charges, without, however, making any record of the silver content. In this way an unknown but small quantity of silver is recovered from southwestern Missouri lead ore. The zinc ores, sphalerite, smithsonite, and calamine, contain notable quantities of cadmium, being fully as rich in this respect as the zinc ores of Silesia, which are the source of the cadmium production of Europe.

Discussion of the cadmium content of these ores is taken up in the chapters entitled "Cadmium," in Mineral Resources for 1908 and for 1917.

The ore deposits of the Joplin district vary in character with the depth of mining. The shallower ores beginning at the surface are universally pockety and are found in residual clays or in "runs" in the basal breccias of the region. The breccias and the forms of the "runs" are largely, if not altogether, due to solution of the limestone strata. One form of run, which is fairly numerous, is the "circle" deposit, which, in the popular view, has come to be nearly synonymous with rich deposits. Small veins, vertical sheets, and thin crevice deposits are often met with in prospecting, but unless they develop into stringers leading into paying ore bodies are forgotten in the multitude of rich pockety deposits which the district has yielded. The blanket deposits or "sheet ground" are found in the Grand Falls chert member of the Boone limestone at depths varying from 100 to 275 feet, according to the topography and the geologic structure. Below this horizon there are, in the beds of Kinderhook age, deposits of disseminated ore. They have been found in prospect shafts or drill holes near Springfield, Aurora, Granby, Carterville, Joplin, Hornet, and Cave Springs, in Missouri; at Galena, in Kansas; and at Quapaw, in Oklahoma.

Lead and zinc concentrates produced in the Missouri part of the Joplin region, 1907–1918.

	Quantity (short tons).	Value.
Lead concentrates	424,033	$26,670,955
Sphalerite concentrates	2,604,878	134,926,815
Zinc carbonate and silicate concentrates	267,270	8,324,620
	3,296,181	169,922,390

The average price per ton received for sphalerite concentrates during the period 1907 to 1918 was $51.80, that for zinc silicate and carbonate was $31.15, and that for lead $62.94.

ASSAYS.

Several of the assayers in the Joplin district make a practice of saving the remnants of blende samples analyzed during the year. At the close of the year the lot is thoroughly mixed and carefully sampled, from which sample an average or composite assay for the year is made. Each assay thus represents several thousand lots. Two representative series of such composite assays are given below. In most cases each sample included in the composite assay represents a carload lot of concentrates.

The first series, by W. W. Petraeus and Evans W. Buskett, of Joplin, gives the result of analyses of composite samples from the general district for the last 16 years. The analyses for 1897–1905, inclusive, were published in the Lead and Zinc News, volume 9, page 8, January 15, 1906. The analyses for 1906–1913 were kindly communicated by

Mr. Petraeus, those for 1914–1917 by Mr. Buskett, and those for 1918 by W. P. Taylor, of Joplin, Mo. Iron was not taken into account until 1900. Some 400 scattering assays, made in 1895–1896, are excluded from the table.

Composite assays of zinc blende from the Joplin region, 1897–1918.

[W. W. Petraeus analyst, 1897–1913; Evans W. Buskett, analyst, 1914–1917; P. W. Taylor, analyst, 1918.]

Year.	Number of lots in the composite.	Percentage.				
		Zinc.	Iron.	Lead.	Copper.	Cadmium.
1897	600	56.64				
1898	1,299	56.99				
1899	3,715	56.67				
1900	3,500	57.36	0.22			
1901	3,683	57.53	2.02			
1902	5,776	57.08	2.24			
1903	6,014	57.30	2.00			
1904	6,220	57.24	2.10			
1905	4,628	57.97	1.84	1.00	0.001	0.198
1906	5,644	57.2	2.00			
1907	6,813	56.8	1.93			
1908	7,873	56.4	1.76			
1909	9,002	56.3	2.00			
1910	8,892	56.6	2.10	1.02	.06	.399
1911	8,920	57.1	2.40			
1912	9,474	57.7	2.40			
1913	7,010	57.1	2.40			
1914	420	56.40	2.70			
1915	1,806	56.76	2.36			
1916	2,190	57.0	2.30	.54		
1917	3,000	57.3	2.25	.52		
1918	[a] 7,436	58.5	1.90	.98	.003	.221

[a] Lots of ore from many districts in Joplin region, including high-grade sphalerite.

A separate assay of 725 lots of high-grade sphalerite was also made by W. P. Taylor, which showed 62.25 per cent zinc, 1.28 per cent iron, 0.111 lead, and 0.53 lime.

The next series of composite assays was communicated by Prof. W. George Waring and Bruce Williams, of Webb City. The original samples were of ores from the different camps of the district except where otherwise indicated. The methods used in making these assays have been published.[1]

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[1] Waring, W. G., The volumetric determination of zinc: Am. Chem. Soc. Jour., vol. 26, No. 1, January, 1904. In addition to the composite assays for 1902 and 1903, shown in the table, the article gives the lead, copper, and cadmium content of a number of ores from individual mines in Missouri, Kentucky, and Illinois.

Composite assays of zinc blende from the Joplin region, 1900–1918.

[W. George Waring and Bruce Williams, analysts.]

Year.	Number of lots in the composite.	Percentage.				
		Zinc.	Iron.	Lead.	Cadmium.	Copper.
1900	3,894	57.30	3.03	....	....	....
1901	5,172	56.00	3.30	....	....	....
1901	2,577	55.30	3.86	....	....	....
1901	[a] ±2,000	55.90	3.47	....	....	....
1902	2,270	57.08	2.65	0.904	0.337	0.050
1903	2,145	57.75	2.32	1.072	.388	.049
1904	[a] 3,800	58.26	2.23	.701	.304	.049
1904	[b] 2,691	58.46	1.97	.720	.430	.050
1904	1,984	58.95	2.10	....	....	....
1905	4,520	58.95	2.00	....	....	....
1906	4,638	58.40	2.20	....	....	....
1906	3,968	58.20	2.29	....	....	....
1907–8	±4,000	58.70	2.00	....	....	....
1909	....	[c] 57.40	2.60	....	....	....
1910	6,377	[c] 57.90	2.60	....	....	....
1911	5,653	58.20	2.35	.856	.450	.034
1912	6,709	56.72	2.50	1.070	.256	.022
1913	7,364	56.82	2.81	1,112	.209	.036
1914	7,981	56.56	2.80	1.30	.287	.038
1915	9,240	57.19	2.40	.985	....	....
1916	10,451	57.95	2.20	.720	.262	.054
1917	10,041	58.10	2.65	.630	.324	.046
1918	[b] 8,255	57.35	2.60	.810	....	....

[a] Joplin. [b] Webb City. [c] The composite sample included some lots of silicate ores.

The complete analysis of the composite sample of the 3,800 lots of concentrate from the Joplin region in 1904, sampled by C. V. Millar and analyzed by Waring, is as follows:

Analysis of composite sample of zinc blende from the Joplin region.

Zinc	58.26	Calcium carbonate	1.88
Cadmium	.304	Magnesium carbonate	.85
Lead	.70	Barium sulphate	.82
Iron	2.23	Silica	3.95
Manganese	.01		
Copper	.049		99.773
Sulphur	30.72		

Analysis of a representative sample of sphalerite jig concentrates from "sheet-ground ore" from the Cartersville (Mo.) area.

[Waring & Williams Laboratories, Webb City, Mo., analyst.]

Zinc	59.20	Germanium, gallium, and indium (spectroscopic determination)	Traces.
Cadmium	.058	Calcium carbonate	Traces.
Lead	.293	Silica (possibly including traces of barium sulphate)	6.971
Iron	1.900		
Copper	.054		99.777
Sulphur	31.301		
Manganese			
Nickel and cobalt	Traces.		

The year 1918 was a disastrous one to nearly all the operators of zinc mines in southwestern Missouri. Costs of mining and milling increased over those of 1917 and the selling price of both sphalerite and zinc silicate declined materially. Development in the "sheet-ground" areas ceased entirely; no new mills were built, and many mills were torn down and moved. Some properties were operated the entire year, but these were a very small percentage of the total producers, for as the price for concentrates declined the number of operating plants decreased until at the end of 1918 the only mills treating ore from "sheet-ground" were the Davey, at Carterville; Bertha A., Sly, and Orange, at Webb City; and the Athletic, at Duenweg. At all these "sheet-ground" mines, except the Davey, work was suspended before June, 1919, and the only large mining operations in the Missouri part of the Joplin region were those at the Oronogo Mutual mine, at Oronogo; the Coahuila, at Carthage; the St. Regis, Little Bill, and C. M. & H., at Joplin; lessees of the American Zinc, Lead & Smelting Co., at Granby; and the Waco, Central, and Gilman mines in the Missouri part of the new Waco district. All of these mines operate in "soft ground" and are making a much higher recovery of concentrates from crude ore mined than usually occurs in the district. Most of the miners found employment in the mines located in the Miami and Waco districts, and the amount of prospecting done at outlying camps was not so great as in former years. Prospecting companies have been formed at Webb City and other places by miners and citizens interested in reviving mining for the benefit of communities which have suffered from the decline in mining operations. The prospecting companies will drill in likely territory and lease proven areas to individuals or companies at low royalties, reinvesting the royalties in further prospecting.

In December, 1918, the agreement between the producers of high-grade lead-free sphalerite and the smelters which purchase that grade of concentrates was abrogated and the wide spread between the prices paid for the different grades of sphalerite was sharply contracted. This spread in prices, which had frequently exceeded $10 a ton, declined to $1 to $3 a ton. The unsold stock of sphalerite in the Joplin region at the beginning of 1918 was estimated at between 25,000 and 30,000 tons, but a very small part of the stocks was held at Missouri mines. There was very little surplus sphalerite in bins at mines in Missouri at the end of 1918. As indicated by the total production for 1918, the weekly average output of concentrates from mines in southwestern Missouri was 317 tons of galena, 338 tons of zinc silicate and carbonate, and 1,837 tons of sphalerite. The weekly average in 1917 was 4,450 tons of sphalerite, 570 tons of zinc carbonate and silicate, and 580 tons of galena. At the end of 1918 it is probable that the weekly output of concentrates in southwestern Missouri did not exceed 900 tons of sphalerite, 200 tons of galena, and 235 tons of zinc silicate. The following quoted base prices apply not only to southwestern Missouri but also to all mines in Oklahoma and Kansas which are in the Joplin region. The average quoted base prices for 60 per cent sphalerite were highest during the period of the agreement between the smelters and the producers of high-grade concentrates, from May to December, when $75 a ton was paid for part of the concentrates produced and allocated by a committee appointed for that purpose.

In the first week in January the base prices quoted were from $50 to $70 a ton. Base prices for the higher grades declined to $68 in the first week of February, to $65 in the last week of February, and to $60 in the last week of March. In April base prices declined to $40 and $37 for low-grade concentrates and to $55 for high grade.

From May until December the base prices for the limited quantity of high grade ore taken by smelters was fixed at $75 a ton, and after the agreement was abrogated the base price for high-grade concentrates was as low as $46 a ton for two weeks in December, and at the end of 1918 it was $55 a ton.

On the lower grades of sphalerite $40 to $43 was the prevailing price in April, May, and the first week of June, advancing to $50 during the latter part of June and the first two weeks in July. It then declined to $47 and early in August it was as low as $42.50. With the exception of one week the prices then held steady at $50 to $52, until the last week in November when the price fell to $42.50 and remained at that price until the end of 1918.

Base prices for calamine or zinc silicate ores followed the sphalerite quotations. The lowest base prices were in April and December, when they ranged from $25 to $30 a ton, and the highest were in November, when they ranged from $38 to $40 a ton.

The quoted price for galena carrying 80 per cent of lead showed wide variations, opening in January at $80 to $83 a ton and closing in December at $65 a ton. During the year galena sold for as much as $106 a ton in September and for as little as $65 at the end of November, although the average price from July to December was from $100 to $103. The high prices did not stimulate the production of lead from southwestern Missouri, for there was a large decrease in production. There will be a further decrease in 1919, owing to the closing of nearly all of the mines working "sheet ground."

The average price per ton paid for sphalerite or blende in 1918 was $51.27, as compared with $71.04 in 1917, $82.60 in 1916, $76.25 in 1915, $38.74 in 1914, $40.70 in 1913, and $50.44 in 1912; and for zinc silicate or carbonate concentrates it was $32.27 in 1918, $40.50 in 1917, $50.21 in 1916, $45 in 1915, $21.13 in 1914, $22.45 in 1913, and $28.95 in 1912. The average price paid for galena concentrates was $89.92 in 1918, as compared with $101.90 in 1917, $84.29 in 1916, $52.52 in 1915, $46.53 in 1914, $51.50 in 1913, $55.36 in 1912, and $55.75 in 1911. These prices are not average base price quotations but are the actual average prices calculated from the quantity sold and the values reported to the United States Geological Survey by the sellers.

The prices received by the producers show that the average actual selling prices of sphalerite in 1918 was $19.77 a ton less than in 1917, a decrease of 28 per cent, and that the corresponding decrease in prices for zinc carbonate and silicate in 1917 was $8.23, a smaller percentage of decrease than in the price of sphalerite.

The average metal content of sphalerite concentrates derived from "soft ground" increased from 58.3 per cent in 1917 to 58.6 per cent in 1918, and the content of those derived from "sheet ground" decreased from 58.6 per cent in 1917 to 57.7 per cent in 1918. The average metal content of the galena concentrates derived from "soft ground" was 1.3 per cent less than in 1917. The average metal content of the galena derived from "sheet ground" was 1.5 per cent more than in 1917.

The recovery of sphalerite and galena concentrates from "sheet ground" increased from 2.11 per cent in 1917 to 2.61 per cent in 1918, because nearly all the "sheet-ground" mines averaging less than 2.50 per cent in concentrates were shut down early in 1918.

The average recovery of concentrates from "soft ground" increased from 4.04 per cent in 1917 to 4.71 per cent in 1918. This was owing to the shutting down of a great many of the larger mines and the higher costs of mining.

The total ore or "dirt" treated decreased from 11,136,100 tons in 1917 to 3,614,200 tons in 1918. The "dirt" treated from "sheet ground" was 1,903,300 tons, a decrease of about 5,785,000 tons, and that from "soft ground" was 1,710,900 tons, a decrease of about 1,737,000 tons.

In 1918 the sphalerite concentrates derived from "sheet-ground" mines amounted to 39,768 tons and the galena concentrates to 9,773 tons. In 1918 "soft-ground" mines yielded 55,774 tons of sphalerite, 6,695 tons of galena, and all of the lead carbonate, zinc silicate, and zinc carbonate concentrates. The production of sphalerite concentrates from "sheet ground" decreased 95,010 tons and that of galena 18,386 tons. The decrease of sphalerite from "soft ground" was 41,036 tons and that of galena 4,194 tons, and the quantity of zinc carbonate and silicate decreased 13,112 tons.

The total value of all concentrates derived from "sheet-ground" mines was $2,850,968, and from "soft-ground" mines $4,096,888. This shows that the value of the production of concentrates from "soft ground" in 1918 amounted to $1,245,920 more than the production from "sheet ground," whereas it was $3,559,903 less in 1917. This radical change in the comparative value of the recovery made from the two classes of mining indicates plainly the disastrous effect of the increased cost of mining "sheet ground."

The Webb City-Carterville-Prosperity district, which includes most of the "sheet-ground" mines, was again much the largest producer of both blende and galena concentrates in southwestern Missouri. It produced 56.4 per cent of the galena concentrates and 28.4 per cent of the sphalerite sold in 1918.

The quantity of crude ore or "dirt" raised is a better indication of the extent of mining activity than the production of concentrates, for the "sheet-ground" ore is of lower average tenor than the "soft-ground" ore. The leading position of the district is more adequately shown by the fact that the estimated quantity of ore mined in the Webb City-Carterville-Prosperity district in 1918 was about 1,300,000 tons, or nearly 37 per cent of the total crude ore raised in southwestern Missouri, and that the output in 1918 was about 3,600,000 tons less than in 1917.

The production of the Webb City district will be much less in 1919 than in 1918, for practically all the "sheet-ground" mines have been shut down and the pumps withdrawn. The Bertha A., Davey, and Kirkwood mines were steadily operated in 1918, and the other "sheet-ground" mines which were worked part of the year were the Sparta, Sly, Yale, Concord, Mahatma, Hurry Up, Media, B. G. M., and Unity. All these mines are now (June, 1919) idle, except the Davey.

Shipments of concentrates derived from "soft ground" or tailings were made by lessees of the Kelly land, Conner Investment Co., Center Creek Mining Co., A. W. Aylor, and the Underwriters Land Co. The total output of all "soft ground" mines was 1,864 tons of galena and 3,734 tons of sphalerite.

The production of the Joplin camp was about one-third as much as it was in 1917. The "sheet ground" mines were inactive or only operated for short periods. Very few new mines were developed, and those that were opened were operated on a small scale. The production from "sheet ground," amounting to 580 tons of galena and 3,989 tons of sphalerite, was reported by the Gibson, A. W. C., Adams Hicks, Paragon, Consumers, and Liberty Bell mines, none of which were in operation at the end of the year. The output from "soft ground" was 1,537 tons of galena, 13,036 tons of sphalerite, and 741 tons of zinc silicate. Most of the zinc silicate came from leases on the Butts and Creller lands. Some of the large producers of sphalerite were the Little Bill Mining Co., Little Martha Mining Co., St. Regis Mining & Smelting Co. (No. 2), C. M. & H. Mining Co., and lessees of the American Zinc, Lead & Smelting Co., Rex Mining & Smelting Co., and Missouri Lead & Zinc Co. Smaller production of concentrates was reported by the Success Mining Co., Grayson Mining & Milling Co., P. L. Swartz, Ben B. Mining Co., Empire Zinc Co., Montgomery Lead & Zinc Co., Smith & Co., Ethel Gray Mining Co.

New mills were built or were under construction in 1918 by the Henrietta Lead & Zinc Co., Bankers Mining Co., C. M. & H. Mining Co., Success Mining Co., and Grayson Mining & Milling Co. The Little Bill mine on the Higgins land was the largest producer in the Joplin camp in 1918.

The Duenweg-Porto Rico production of zinc and lead concentrates in 1918 was 2,152 tons of galena, 13,983 tons of sphalerite, and 2,431 tons of zinc silicate. About 80 per cent of the output was from "sheet ground" mines, and as the only mines of that class in operation after June, 1918, were the Athletic and the Coahuila, there was a very large decrease in the production.

There will be a much lessened output in 1919, for every "sheet ground" mine at Duenweg has suspended operations. "Sheet ground" ore was milled in the early part of 1918 at the Vogey, Evans Hall Soy, St. Regis No. 1, and Scott concentrating plants.

The production of sphalerite from "soft ground" mining was only 1,680 tons, most of which was shipped by the E. & N. Mining Co. and by lessees working the upper ground on the old Boston-Duenweg land. Most of the zinc silicate was shipped by the C. C. & B. Mining Co., M. M. & B. Mining Co., on the Carter land, and lessees on the Burch land.

The Granby district produced 11,737 tons of zinc silicate and carbonate, which was 66 per cent of the total output of that class of zinc ore in Missouri in 1918. There were also shipments of 387 tons of galena and 5,171 tons of sphalerite, so that the value of the concentrates sold from that district was only exceeded in value by the shipments from the Webb City, Joplin, and Duenweg camps. There was considerable drilling done outside the land of the American Zinc, Lead & Smelting Co., and a good production was made from the Zogg, St. Paul, and the Douglas lands.

There was also some high-grade sphalerite sold by the M. K. & T. Mining Co. before operations were suspended. Most of the output, however, was, as usual, from leases of the American Zinc, Lead & Smelting Co., and although the shipments of concentrates were less in 1918 than in 1917, the ratio of decrease was much less than in most districts.

At Oronogo the production of galena was 713 tons less and that of sphalerite was 2,479 tons less than in 1917. The Oronogo Mutual mine, which operated steadily all year, was taken over by Charles T. Orr. The production of the Oronogo Circle mine decreased considerably owing to delays occasioned by readjustments at the milling plant and to the difficulty in handling the mixture of clay, shale, and ore sent through the gyratory crusher operated underground.

Carthage was the only district in Missouri which had an increased output of sphalerite. The production increased from 4,827 tons in 1917 to 6,517 tons in 1918. Most of this was the output of the Coahuila No. 2, but the Hartford, Pleasant Valley, and Annalee mines shipped large quantities of sphalerite.

The production of lead and zinc decreased in all the other smaller districts in the Joplin region. The only large producing property at Sarcoxie was the Flannery; at Cave Springs, the Imperial; at Alba-Neck City, the Purcell, Tar Creek, Sponable, and Missouri; at Aurora, the Red Wasp and the lessees of the Cleveland-Aurora and the United Zinc Co. lands.

There was very little mining in the Spring City and Thoms Station camps and the only new mill built was that of the Julian Mining Co. on the Willis land. About 186 tons of galena and 452 tons of high-grade sphalerite were shipped from the Big Ben, Gumbo, and Clark mines, near Springfield, and small shipments of lead and zinc were made from Stark City by the Stark City Mining Co., which built a 150-ton concentrating plant and sunk a 173-foot shaft in 1918.

The only shipments of ore from Christian and Wright counties were a few cars of zinc silicate and carbonate. There were three or four companies developing or prospecting at Mansfield, in Wright County, but the only concentrates shipped were from the Pioneer mine of the Mansfield Mining & Development Co., which completed a 100-ton mill in September and milled some ore taken out in sinking an 80-foot shaft. The old Red Bird mill was repaired but not operated in 1918.

The condition of the zinc and lead mining industry in Missouri, Oklahoma, Kansas, and Arkansas at present (June, 1919) was very tersely yet comprehensively stated by Otto Ruhl, of Joplin, Mo., in his address before the delegates of the American Zinc Institute at the annual meeting in St. Louis, on June 10, 1919. Mr. Ruhl's remarks were as follows:

INDUSTRY HIT HARD.

Hard hit in that year [1918], the zinc mining industry of these four States to-day, is in even a worse state than then. In the State of Missouri one can count the active mining plants practically on the fingers of your two hands. Arkansas has but a negligible output of zinc ore to-day. The two States of Oklahoma and Kansas are supplying the bulk of the output. Singularly enough we find the efforts of the field to curtail its output but partially successful, a fact due to the gradual but inevitable fruition of prospecting effort begun two years ago. It has been said, and truthfully so, that 10 years' prospecting was done in the Oklahoma field in two years' time. The results have been the development of a large number of mines whose output has been thrown on the market and kept up the output of this district even in the face of untoward price conditions to an unusual level. Much of this output is not the result of studied operation, but incidental to prospecting and development and in most cases produced at a staggering loss. Yet the tonnage of these mines in the aggregate has maintained the output of the district at close to 10,000 tons per week.

MANY MILLS CLOSED DOWN.

It is difficult to reconcile this heavy production with the facts generally known as to prices for ores, and with the fact that so many mills are closed down. A census taken of the mills of the field within the past month showed out of 208 mills a total of but 58 operating, or approximately 28 per cent of the potential producers. With the 58 operating, however, the bulk of the tried operators and the low-cost mines are found, a synonym for either high-class operation or extremely rich properties.

The following tables of shipments and prices for corresponding months of 1918 and 1919 show a consistent decline in prices received, but no such decline in output:

Comparative production all grades of zinc ore, 1918–1919.

Month.	1918	1919
January	32,995	27,102
February	22,250	40,228
March	47,955	50,851
April	44,315	47,579
May	44,315	47,579
	194,325	202,659
Surplus on hand	27,500	16,000
	221,825	218,659

Comparative zinc ore prices, 1918–1919.

Month.	1918		1919	
	Blende.	Calamine.	Blende.	Calamine.
January	$57.02	$32.67	$43.44	$35.01
February	55.02	33.00	41.78	26.27
March	50.14	34.73	41.54	27.74
April	42.03	32.93	38.87	26.61
May	47.79	31.00	37.80	24.80

Compared with 1918, the 1919 period shows an average reduction of $11.89 for blende ores and $3.06 for calamine ores.

One would naturally anticipate that the reason for this condition must be explained by a greatly reduced cost of operation. While there have been some reductions in costs they have not been commensurate with the reduction in prices received for product. The reductions in cost have been approximately 10 per cent in labor and a small reduction in hard iron and powder. Other costs either have been maintained or actually advanced, as in the case of power and lubricants. A reduction in one class of supplies is practically balanced by advances in others. It therefore becomes increasingly apparent that much of the production being maintained is produced at a loss. Recently, when the price of ore dropped to a $35 base, some of the very strongest operators in the field shut down some of the best and richest properties, while weaker concerns and poorer properties can still be found desperately trying to keep going.

Under these conditions the production of the field is approximately 9,000 to 10,000 tons and its potential production on a $45 to $55 market can be readily determined at 50 to 60 per cent more. From this situation it is evident that Joplin operators are hoping for a hurried revival of zinc consumption and a greatly increased use for this metal.

END OF WAR ENDED COOPERATION.

The end of war brought with it the end of all price agreements and the cooperation between smelters and ore producers. The whole market situation reverted to the old open system where everyone was for himself and the devil take the hindmost. The cooperative action between the sheet zinc manufacturers and the high grade zinc ore producers, which was so satisfactory during the war period, to-day is almost forgotten history, and a similar movement to take care of classes of ores and with all the smelters met a like fate before it was more than born. Certainly the industry needs such cooperation to-day as much, if not more, than during the war period. But so far as one can now see the inevitable law of the survival of the fittest must take its course, and only those with unusually rich deposits can survive the squeezing process of high production costs and low ore prices. How long this process must continue to bring about the extermination of the output which will again balance local supply and demand is difficult to answer.

OPTIMISM PREVAILED LAST YEAR.

It was pointed out at last year's meeting that the souls of operators were born, kissed by the enthralling rapture of eternal optimism. The past year's history is confirming evidence that they will endure impossible conditions and yet live. If they can not produce ore for a profit they do it for philanthrophy, and the world gets its zinc metal mined for less than cost.

The salient features of the year's history as reflected in the zinc mining industry of Missouri, Kansas, Oklahoma, and Arkansas are:

1. That the production in Missouri and Arkansas has grown smaller since last year.
2. Output of Oklahoma and Kansas holds strongly at 9,000 to 10,000 tons (weekly).
3. Production is maintained at a high level in spite of large numbers of mills closed down.
4. Only the richest ore deposits can be worked and the best organized companies can operate and much of the ore is being produced at a loss.
5. Ore prices declined $11.89 per ton over last year, but this did not greatly reduce output of ore.
6. Cost of production remains high and changes in some items while lower have been balanced by others that have advanced.
7. End of war brought all price agreements to an end and no cooperative efforts since have been successful.

CENTRAL AND SOUTHEASTERN MISSOURI.

The ore deposits of central and southeastern Missouri reach in a more or less connected belt from the region of Benton, Pettis, Morgan, Moniteau, Cole, and Miller counties on the northwest to the northern and eastern flanks of the St. Francis Mountains on the southeast. It is also true that there are scattered areas where more or less mining has been done all the way between the northwest end of this belt and the Joplin region, so that strictly speaking the lead and zinc deposits of Missouri practically form a zone around the northern half of the Ozark dome. A brief description of the ore deposits in central and southeastern Missouri is given in the separate chapter entitled "Silver, copper, lead, and zinc in the Central States in 1915," which may be obtained upon application to the Director, United States Geological Survey, Washington, D. C.

The ore in the southeastern Missouri region is almost wholly lead, although a considerable zinc deposit occurs at Valle mines, some 6 miles north of the Bonneterre district, and a considerable quantity of zinc silicate is mined in various parts of Washington and Jefferson counties. A certain percentage of zinc is also found in the disseminated lead ore, the ore from one shaft being reported to run occasionally as high as 2 per cent of zinc for a week at a time. The zinc occurs more plentifully in the Leadwood-Flat River district and may lie near the contact of the Bonneterre limestone with the Lamotte sandstone or some distance above it. In the lead concentrates zinc ranges from 1 to 5 per cent or more. In the maximum proportions mentioned the zinc makes trouble in lead smelting, and for this reason some of the concentrating plants remove the zinc as a table middling.

Copper, nickel, and cobalt also occur in the ore, in considerable quantity in the vicinity of Fredericktown, and in small quantity, irregularly in nearly all the deep mines. It is only near Fredericktown that the copper, nickel, and cobalt content of the ore has been the object of mining, yet a concentrate of these metals has been recovered as a table middling at several plants in other parts of the district, and 3,115 tons of copper concentrates were shipped in 1915, 2,878 tons in 1916, 2,304 tons in 1917, and a much larger quantity in 1918, as the Missouri Cobalt Co. shipped a large quantity of low-grade concentrates.

In the disseminated ore district the production since 1869 increased rapidly and is estimated by Buckley to have amounted to 1,202,607 tons of lead concentrates, valued at $59,869,354, for the period between 1869 and 1906, inclusive. The mine production of southeastern and central Missouri has been reported to the United States Geological Survey since 1907.

Mine production of lead and zinc concentrates in southeastern and central Missouri, 1907–1918.

Year.	Lead concentrates—galena.		Zinc concentrates.			
			Sphalerite.		Carbonate and silicate.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1907	156,663	$7,910,398	100	$3,500	1,095	$15,330
1908	183,095	6,906,116	42	1,050	1,369	20,436
1909	210,620	8,823,297	41	938	1,284	17,334
1910	210,890	9,360,309	....	....	929	19,000
1911	219,145	10,293,400	113	3,990	510	11,576
1912	218,803	9,849,854	40	1,292	1,051	21,020
1913	219,511	9,580,893	33	574	639	13,491
1914	249,165	9,710,125	40	700	497	11,282
1915	278,104	12,773,579	43	1,064	1,061	39,460
1916	307,025	20,720,737	365	14,400	1,030	42,129
1917	306,473	30,070,995	186	16,344	293	7,145
1918	271,506	20,507,064	13	285	235	6,845

A comparison of the estimates for the period of years to 1906 given by Winslow and Buckley for Washington and St. Francois counties (which have supplied a very large proportion of the galena ores from southeastern and central Missouri) with the figures in the preceding table indicates a production of galena concentrates during the last 12 years much greater than the entire output of southeastern and central Missouri prior to 1907.

The lead ore of southeastern Missouri carries a small proportion of silver, the average being less than 1 troy ounce to the ton of lead concentrates. The resulting pig lead likewise carries silver, together with a little copper, nickel, cobalt, and traces of antimony and arsenic, and is sometimes commercially known as "Missouri chemical" lead in contradistinction to "Missouri soft" lead from the Joplin region. An average of about 15 per cent of the total lead concentrates from southeastern Missouri is desilverized. The silver so recovered does not pay for the refining charges, but the desilverized lead commands a slightly higher price, making up the difference. As the silver content of the concentrates is so small, it is disregarded in their sale, and therefore the smelter reports are relied upon for the production of silver. As already explained, the quantity of silver produced during any year bears no direct ratio to the quantity of silver-bearing lead concentrates smelted during that year, for the reason that the silver bullion is stored and refined in batches at convenient times.

The output of silver in Missouri in 1918 was derived mainly from refining pig lead, the only other source of production being about 7,892 ounces recovered from copper ore and from copper concentrates recovered in dressing lead ores, which were shipped to smelters.

The production of silver in southeastern Missouri was 46,939 fine ounces in 1918, as compared with 61,586 fine ounces in 1917, 129,450 fine ounces in 1916, 57,756 fine ounces in 1915, 61,168 fine ounces in 1914, 35,620 fine ounces in 1913, 35,438 fine ounces in 1912, 49,867 fine ounces in 1911, 33,096 fine ounces in 1910, 14,188 fine ounces in 1909, and 49,131 fine ounces in 1908. The production of silver in 1918 was recovered from about 52,000 tons of lead concentrates and from copper ore and concentrates that averaged less than 1 ounce a ton.

The crude lead ore mined in the disseminated lead district in 1918 amounted to 5,532,600 tons, against 5,887,900 short tons in 1917, 5,467,500 short tons in 1916, 5,067,400 short tons in 1915, 4,718,300 short tons in 1914, 4,250,800 short tons in 1913, and 4,064,366 short tons in 1912. The crude ore in 1918 yielded 5.01 per cent of lead concentrates, which averaged 66.8 per cent of lead. The average value per ton of the lead concentrates in 1918 was $75.53, as compared with $98.01 in 1917, and the concentrates were slightly higher in lead content than in 1917. The output of galena concentrates was 271,153 tons, valued at $20,479,839 in 1918, against 306,473 tons, valued at $30,070,995 in 1917. As several of the large producers not only mine but also smelt their lead concentrates, the values given for concentrates are to a certain extent arbitrary. The galena concentrates produced in the southwestern Missouri region containing a higher lead content are mainly sold on bids from various purchasers, and the prices for those lead concentrates are not comparable with prices given for concentrates of the disseminated lead district.

Analyses of ores mined in disseminated lead district in southeastern Missouri and of the various grades of resulting concentrates.[a]

	Ag	Cu	Pb	SiO_2	Fe	Al_2O_3	CaO	MgO	Zn	S	Ni and Co
	Ozs. per short ton.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Ore (crude)	0.12	0.06	5.7	5.0	4.1	4.9	25.5	14.2	0.8	2.0	......
High-grade concentrates	.7	.13	73.2	1.0	3.5	....	2.6	.8	.4	15.0	0.05
Medium-grade concentrates	1.3	.12	68.6	1.4	4.6	....	3.1	1.4	.8	15.5	.06
Low-grade concentrates	1.0	.30	65.8	.5	3.1	.5	4.3	2.8	1.7	13.7	......
Flotation slimes, concentrates	......	.50	45.0	9.6	4.4	3.1	7.5	4.2	4.0	12.3	......
Flotation slimes, high-grade concentrates	3.7	.05	57.8	6.0	2.7	....	2.2	1.4	9.4	15.5	......
Joplin (southwestern Missouri) concentrates	......	......	80.2	1.1	1.0	....	.4	......	1.7	13.3	......

[a] Garlichs, Herman, Metallurgy of lead ores in the lower Mississippi Valley: Am. Inst. Min. Eng. Bull., July, 1917, pp. 1041-1046.

NOTE.—A typical analysis of southeastern Missouri undesilverized lead is as follows: Ag, 0.0080 (2.4 oz. per short ton): As, trace: Sb, 0.0030: Bi, trace: Cu, 0.0800: Fe, 0.0015: Zn, trace: Ni and Co, 0.0080: lead by difference, 99.8995.

The production of sphalerite from central and southeastern Missouri in 1918 amounted to only 13 tons, valued at $285. The production of zinc carbonate from southeastern Missouri in 1918 amounted to 235 tons, against 293 tons in 1917. All of the zinc carbonate was shipped from the Tamm mine near St. Clair in Franklin County and the Valle mine in Jefferson County. The Tamm ore is taken from an open cut in the side of a hill, and the equipment consists of a crusher, rolls, 3 Deister-Overstrom tables, and 2 hand jigs. Only one lessee operated at the Valle Mines and prospecting for galena was done on the Garatee tract until the inefficiency and scarcity of labor caused operations to be discontinued in November, 1918.

The Osage Mining Co. sunk a 112-foot 2-compartment shaft at Damsel in Camden County and installed considerable surface equipment but produced no ore in 1918.

The quantity of galena recovered from shallow diggings in Washington and Jefferson counties was only about 350 tons. The high wages paid by the large mines in St. Francis and Madison counties attracted miners and laborors who normally lease and work many of the shallow diggings. The ore, which occurs at shallow depths and in association with barytes, is mined in a small way and at odd times by the barytes miners. This ore is all hand picked and cleaned, there being no concentrating plants. There are numerous other shallow lead and barytes diggings scattered over Washington County which are worked by small operators and farmers, who sell their product to the country merchants and to ore buyers. Much of this ore was purchased by J. F. Evans, of Potosi.

The production of galena concentrates from the disseminated lead district showed the first large decrease in recent years, the output of concentrates decreasing about 35,000 tons and the value nearly $10,000,000. The district was, however, fairly prosperous in 1918, although the margin of profit to operating companies was much less than in 1917. The quantity of crude ore treated decreased 350,000 tons and the percentage of recovery in concentrates was a little less owing to some low-grade ore. One or two of the small producers closed down entirely late in the year and the larger companies curtailed their operations to about five-sixths of capacity in December. There was no prolonged scarcity of labor, although it cost more and was less efficient than usual. Wages were not reduced until January, 1919, when they were cut 20 per cent. Very little development was done other than by the old companies and the only new territory in which exploration work was done was near Annapolis in Iron County where it is stated that a deposit of disseminated lead ore was located in drill holes at depths between 250 and 500 feet.

The St. Joseph Lead Co., which includes the old Doe Run property, produced nearly one-half the lead output of southeastern Missouri. Seven shafts, ranging from 400 to 500 feet in depth, five at Flat River and one each at Bonne Terre and Lakewood, were operated in 1918. The concentrating plant operated in the Flat River district has a capacity of 4,000 tons a day; that at Bonne Terre, 2,400 tons; and that at Lakewood, 1,800 tons. All mill machinery, mine hoists, pumps, and compressors are motor driven. No. 16 shaft at Rivermines, on which sinking was commenced in December, 1917, was bottomed at a depth of 638 feet in November, 1918. Operations were curtailed on December 7, 1918, to a basis of a five-day week, the various plants closing on Friday at the end of the night shift and resuming work on Monday morning.

Another large settling pond for tailings was under construction and a tailing stacker was installed.

The Desloge Lead Co. also had an increased output. Three shafts having an average depth of 366 feet were operated in 1918 and a Permutit water-softening system was added to the concentrating plant, which has a capacity of 1,500 tons a day. A sprinkler system for protection from fire was installed at the mill and at No. 3 shaft. A Lowden drier was also added to the flotation plant to reduce the moisture in the concentrates.

The mines and mills of the Federal Lead Co. are at and near Flat River, St. Francois County. Four shafts were operated in 1918 and 1,900,000 tons of crude ore were milled. Mills Nos. 2 and 3 were operated steadily throughout the year and a filter and drying plant for flotation concentrates was completed at mill No. 3.

The mines of the St. Louis Smelting & Refining Co. are in the vicinity of the village of St. Francois, about 1 mile north of Flat River. The concentrating plant is modern, having a capacity of 2,500 tons per day of 24 hours, and is equipped with gyratory crushers, Hancock jigs, Overstrom classifiers, and Butchart tables, and slime and settling tanks. A central steam-power plant drives air compressors and electric generators. The mill, hoists, and pumps are operated by electricity as well as the underground haulage and the trams for handling the ore from the shafts to the mill. This company also operates a lead smelter and refinery at Collinsville, and the lead concentrates produced by the mines and also those derived from crude ore purchased from the Baker Lead Co. and the Boston Elvin Lead Co. were smelted at that plant.

The Baker Lead Co., which owns the Jake Day tract near Big River, operated one shaft 400 feet in depth until December 20, 1918.

There is no concentrating plant on the property and the ore was hauled to the National mill of the St. Louis Smelting & Refining Co., to which the crude ore was sold.

The Boston Elvins Lead Co., which owns a 40-acre tract at Elvins, also sold its crude ore. The shaft at this mine is 575 feet deep and 3-ton skips were used for hoisting ore. The shaft, which is very wet, was unwatered by means of a centrifugal pump and some ore was mined and shipped before the mine was again shut down in November, 1918.

The old Mine La Motte property, in Madison County, which was taken over by the Missouri Metals Corporation, shipped some lead concentrates to the St. Louis Smelting & Refining Co., but held a considerable quantity of cooper concentrates. In certain parts of the property copper and nickel-cobalt sulphides occur, but the mining of such ores had been avoided in recent years until the Missouri Metals Corporation took over the property. The company is now in the hands of the receiver, Festus J. Wade, of St. Louis.

The ore deposits at Mine La Motte are relatively shallow, and the mine development during 1918 was largely in the nature of stripping the overburden to bedrock, so that the property could be worked by open cuts and all underground mining suspended. The crushing plant and the large picking plant under construction was finished and operated in 1918. The attempt to strip the heavy overburden of limestone proved very expensive, and at present it is uncertain whether operations will be resumed.

The Buckeye or North American mine, at Fredericktown, was unwatered by the Missouri Cobalt Co. A concentrating plant of 300 tons capacity and a 100-ton smelter completed in 1917 were actively operated in 1918. A new refinery for the treatment of cobalt, nickel, and copper was constructed. The lead concentrates produced were smelted at the Federal plant and the copper concentrates containing nickel and cobalt were shipped to the Grasselli Chemical Co., Grasselli, Ind., for making sulphuric acid. The cinders from the copper concentrates are then returned to the smelter and refinery of the Missouri Cobalt Co. for the recovery of the cobalt, nickel, and copper. A considerable quantity of copper was sold in 1918, but no nickel or cobalt was marketed.

OKLAHOMA.

By J. P. DUNLOP.

PRODUCTION.

Mine production of lead and zinc in Oklahoma in 1918.

District.	Ores.						Metal content.[a]			
	Lead concentrates (galena).		Zinc concentrates.				Lead.		Zinc.	
			Sphalerite.		Carbonate and silicate.					
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Ottawa County:										
Miami	69,693	$6,170,537	298,749	$15,101,765	......	......	55,925	$7,941,350	160,418	$29,196,076
Quapaw	169	15,594	1,953	80,370	......	......	133	18,886	975	177,450
Peoria	50	4,300	......	......	25	$646	39	5,538	8	1,456
	69,912	6,190,431	300,702	15,182,135	25	646	56,097	7,965,774	161,401	29,374,982
Total, 1917	32,775	3,301,534	159,656	10,762,324	268	9,128	26,358	4,533,576	85,835	17,510,340

[a] In calculating the metal content of the ores for assays allowance has been made for smelting losses of zinc, but not of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead is calculated from the average sales price of all grades. The price of zinc for 1917 and 1918 is the average sales price of all grades reported by smelters.

The following table gives the output of crude lead and zinc ore for the whole State of Oklahoma, but it was thought advisable to calculate the tenor of crude ore and concentrates as well as assay content and value of concentrates separately for the Miami and Quapaw districts, inasmuch as the character of the ground operated in these districts has, until the new mines in the easterly extension of the Miami district, near Quapaw, were opened in 1918, differed so radically that general calculations for the State would be valueless:

Tenor of lead and zinc ore and concentrates produced in Oklahoma, 1917 and 1918.

	1917	1918
Total crude ore milled in Oklahoma .... short tons..	3,523,200	5,754,700
Miami district:		
Total concentrates in crude ore—		
Lead .... per cent..	0.94	1.22
Zinc .... do....	4.56	5.23
Metal content of crude ore—		
Lead .... do....	.76	.98
Zinc .... do....	2.72	3.13
Average lead content of galena concentrates .... do....	80.4	80.2
Average zinc content of sphalerite concentrates .... do....	59.6	59.6
Average value per ton—		
Galena concentrates	$100.77	$88.54
Sphalerite concentrates	67.44	$50.55
Quapaw district:		
Total concentrates in crude ore—		
Lead .... per cent..	.51	.36
Zinc .... do....	2.30	4.15
Metal content of crude ore—		
Lead .... do....	.41	.28
Zinc .... do....	1.32	2.30
Average lead content of galena concentrates .... do....	78.8	78.7
Average zinc content of sphalerite concentrates .... do....	56.9	55.5
Average value per ton—		
Galena concentrates	$95.10	$92.27
Sphalerite concentrates	$61.41	$41.19

The chapter on the production of lead and zinc in Oklahoma in Mineral Resources for 1914 contains a brief history of mining in the various districts and also the estimated total production of each district, by years.

Mine production of lead and zinc concentrates in Oklahoma, 1891–1918.

District.	Lead concentrates (mainly galena).		Zinc concentrates.			
			Sphalerite.		Zinc silicate and carbonate.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Peoria	2,092	$100,398	97	$3,129	2,704	$72,370
Quapaw	3,998	257,454	33,542	1,449,002	164	2,692
Miami	159,736	12,915,361	635,144	34,644,379		
Davis			558	27,399	899	24,592
	165,826	13,273,213	669,341	36,123,909	3,767	99,654

The total value of the lead and zinc concentrates produced in Oklahoma in 1918 was approximately 52 per cent greater than in 1917 and followed an increase of 159 per cent in 1917 and of 127 per cent in 1916.

The lead and zinc deposits of northeastern Oklahoma, so far as known, are confined to the limits of Ottawa County and form the southwestern extension of the Joplin region. There are three camps, Peoria, Quapaw, and Miami, in this county, in which extensive mining has been done, and a fourth, the Sycamore Creek district, along the Seneca fault block from 2 to 3 miles southwest of Seneca, Mo., in which considerable prospecting has been done and some ore mined.

The lead and zinc deposits in southern Oklahoma are near Ravia, at the southeast end of the Arbuckle Mountains, and near Davis, Murray County, at the northwest end of the same range.

The quantity of crude ore milled in Oklahoma increased from 3,523,200 tons in 1917 to 5,754,700 tons in 1918, notwithstanding that the quantity of ore milled by the old mines near Commerce was very much less in 1918 than in 1917.

The value of the recoverable lead and zinc produced at mines in Oklahoma in the year 1918 was $37,340,756, compared with $22,043,916 in 1917. The metal content of lead concentrates increased from 26,358 tons, valued at $4,533,576, in 1917 to 56,097 tons, valued at $7,965,774, in 1918, and the recoverable zinc increased from 85,835 tons, valued at $17,510,340, to 161,401 tons, valued at $29,374,982.

In 1918 the lead concentrates produced in the Oklahoma districts were of about the same grade as those shipped in 1917. The average metal content of the sphalerite concentrates from Miami ore increased from 51.8 per cent in 1912 to 53.6 per cent in 1913, to 54.8 per cent in 1914, to 55.7 per cent in 1915, to 55.77 per cent in 1916, and to 59.6 per cent in 1917 and 1918, and was 4.1 per cent more than the average metal content of the sphalerite from the Quapaw district in 1918.

The lead concentrates from Oklahoma sold in 1918 were 37,137 tons more in quantity and $2,888,897 greater in value than in 1917. Miami district (in Oklahoma only) produced about 70 per cent of the total production of lead in the Joplin region, exceeding the Webb City-Carterville district by about 60,400 tons. The Oklahoma shipments of sphalerite in 1918 amounted to 300,702 tons, valued at $15,182,135, an increase of 141,046 tons in quantity and of $4,419,811 in value.

The shipments of zinc carbonate and silicate decreased from 268 tons in 1917 to 25 tons, valued at $646, in 1918. The Miami district yielded about 99.4 per cent of the sphalerite concentrates and more than 99 per cent of the galena concentrates sold in Oklahoma in 1918.

Peoria district.—The production at Peoria, the oldest mining camp in the State, was only 50 tons of galena and 25 tons of zinc silicate, all of which was mined by small operators at shallow levels. The Mount Nebo Lead & Zinc Co. erected a mill in 1918, which made a few test runs on ore taken from a new shaft. A small quantity of sphalerite was recovered, but none was shipped in 1918. A number of stock companies were formed to operate or lease mines near Peoria, but practically no work was done by any of them.

Davis district.—No shipments of lead or zinc in 1918 were reported by any mines in the Davis district, in Murray County, southern Oklahoma.

Quapaw district.—There was a large amount of drilling, shaft sinking, and mill construction in the Quapaw district. The total production of concentrates, however, was small in 1918, and none of the mills were in steady operation. The sales of galena decreased from 208 tons in 1917 to 169 tons in 1918, and those of sphalerite increased from 934 tons in 1917 to 1,953 tons in 1918. The total value of the concentrates sold in 1918 was $95,964, an increase of $18,827. Many leases at the Lincolnville and Sunnyside camps were acquired by new owners and drilled to levels lower than the ore bodies worked in former years, and old shafts were deepened or new ones sunk, but none of these new properties except the Diamond Joe Mining Co., at the extreme northerly end of the district, shipped more than 500 tons of concentrates. Some of the mines which contributed to the shipments made in 1918 were the old Sambo, on the Buck land; the Kentex, Old Reliable, the Katy (now owned by the Farmers Lead & Zinc Co.), the Hawkins and Lead Boy on the land of the Crescent Lead & Zinc Co.; the True Blue, on the Horseshoe land; the Bethlehem (old Hannibal), the Red Eagle, the Quajack, the Sterling (now abandoned), the Lucky Joe, the Doris (abandoned), and the Bendene. Very few of these mines were worked at the end of 1918, although nearly all of them are equipped with milling plants. Among the mines operated in 1918 from which no concentrates were shipped were the Catholic Mining Co. and the Canton Mining Co. (old Mission), at Lincolnville; the Big V Mining Co., Little Jewel Mining Co., McCurdy Mining Co., near Quapaw; the West Virginia Mining Co. and Leadville Mining Co., at Sunnyside.

Miami district.—A history of the mining in this district, including the output by years for the period 1908 to 1914, and the location of the mines and mills, was given in this report for the year 1914, copies of which may be obtained on request. The reports for the years 1915, 1916, and 1917 contain full views of the production, new territory prospected, new mines opened, and new mills erected in those years.

A brief description of the ore deposits in the Miami district of Oklahoma is given in the separate chapter of Mineral Resources entitled "Zinc in 1915,"[1] which may be obtained upon application to the Director, United States Geological Survey, Washington, D. C.

The mines of the Miami district in 1918 shipped 69,693 short tons of galena concentrates, valued at $6,170,537, and 298,749 short tons of sphalerite concentrates, valued at $15,101,765, an increase of 37,136 tons of galena concentrates and of 140,027 tons of sphalerite concentrates when compared with the output of 1917. The average price of the galena concentrates decreased $12.23 a ton, and the average price of sphalerite concentrates, of which more than 4 times as much was shipped, decreased $16.89 a ton. This unusual increase of about 92 per cent in the quantity of concentrates shipped, following an increase of nearly 200 per cent in 1917, does not adequately show the development during the last two years, for only a part of the milling plants were operated at capacity and many were idle most of 1918.

It is difficult to realize the possibilities of the output had there not been some shortage of labor and supplies and lower prices of both galena and sphalerite.

It was not advisable to force such rapid development, or rather production, in face of high operating costs and declining values. Many of the mines recovered large quantities of galena which made operation profitable, notwithstanding the much lower selling price of sphalerite. The operating costs at Miami are greater than in most of the districts in the Joplin region and the royalties paid averaged 50 per cent more. The "dirt" or ore mined in 1918 averaged 1.75 per cent more in concentrates than that of all the "dirt" from "soft ground" treated in southwestern Missouri, and the average quantity of galena in the "dirt" at Miami was three times as great. The increased recovery of concentrates in the Miami district compensated for the higher operating costs, but it is certain that many of the Miami mines could not have profitably mined ore during 1918.

The royalties proved so burdensome to many lessees that an effort is being made to reduce them considerably in order that ore may be mined which can not at present be profitably worked. The proposed arrangement is a sliding scale of royalty based on the recovery of concentrates from the ore and the selling price of galena and sphalerite concentrates. Undoubtedly a part of the development done in the district in 1918 was necessary to prevent leases being forfeited and without any expectation of profits under existing conditions. The supply of labor was generally sufficient, although the efficiency of such labor was decidedly below normal until December, 1918. There was a slight reduction in the cost of supplies in December and a very large increase in the efficiency of labor as the miners realized that many of the operators desired to give them steady employment which could only be accomplished by lowering the costs of mining and milling. All the mines are adequately provided with shipping facilities by rail, and the construction of rock roads and permanent bridges for vehicles was continued, although hampered by the scarcity of labor.

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[1] See Siebenthal, C. E., Zinc: U. S. Geol. Survey Mineral Resources, 1915, pt. 1, pp. 888-890, 1917.

The production in 1918 in the Miami district (in Oklahoma) was that of about 125 mills, of which 10 were in the old Commerce camp and the remainder in the territory north and northeast to the Kansas State line and east to Quapaw. Many of the mills were not operated until the latter part of the year and others were operated intermittently. It is estimated that in June, 1919, there were more than 200 concentrating plants—many of them of large capacity—built or under construction in Ottawa County.

The quantity of crude ore mined and milled increased from approximately 3,479,900 tons in 1917 to 5,707,000 tons in 1918. The percentage of concentrates recovered from crude ore milled was larger than in any other district in the Joplin region, and, with increased operations in the northern part of the district, the ore treated showed an increase in percentage of concentrates recovered from 5.50 per cent in 1917 to 6.45 per cent in 1918. As a larger proportion of the output of the Miami district in 1918 was derived from mines north of Commerce, which usually yield zinc concentrates of higher grade than those near Commerce, the average metal content of all blende concentrates sold increased from 57.77 per cent in 1916 to 59.6 per cent in 1917 and 1918. The average metal content was 51.8 per cent in 1912, 53.6 per cent in 1913, 54.8 per cent in 1914, and 57.7 per cent in 1915, so that the total increase in the zinc content of the sphalerite sold has been more than 7.5 per cent in six years.

The separate assays reported showed the zinc content to range from 48 to 63 per cent, but most of the blende assayed between 57 and 60 per cent. Assays of 965 lots of zinc concentrates in 1918 by Thor Relling, of Miami, showed an average content of 60.55 per cent of zinc, 0.75 per cent of lead, and 1.10 per cent of iron, and the average content of 198 lots of galena concentrates assayed was 79.15 per cent of lead. These assays reported by Relling approximate very closely the average lead content of galena concentrates and the zinc content of sphalerite concentrates given in the table for the Miami district, though his assays did not include any of the high-grade concentrates produced at the Eagle-Picher mines. The average selling price of galena concentrates decreased from $100.77 in 1917 to $88.54 in 1918, and that of blende concentrates decreased from $67.44 in 1917 to $50.55 in 1918.

The recovery of galena concentrates from all the mines averaged about 1 ton to 4.3 tons of sphalerite, which is a much higher average than in any other district in the Joplin region. The proportion of galena concentrates recovered from the "dirt" mined showed wide variations, ranging in different mines from less than 1 ton of galena to 100 tons of sphalerite to 4 tons of galena to 1 ton of sphalerite. The mines lying north and northeast of the Quapaw mine near Commerce reported 68,437 tons of galena and 295,989 tons of sphalerite; those lying southwest of the Quapaw mine to the southern limits of the district reported 1,256 tons of galena and 2,760 tons of sphalerite. None of the mines in the Horse Shoe Lake area, immediately north of Miami, reported any shipments in 1918, and the only development done was by Denny Bros, The old mines at Commerce, the Mispah mine, the farthest south, those on the northwesterly ore run extending to the old Haymaker mine, and those on the northeasterly ore run as far as the Quapaw mine are located on the Sarah E. McBee and the Commerce Mining & Royalty Co. leases. The producers on McBee land that shipped concentrate in 1918 were the Miami Zinc & Lead Co. and the Miami Volunteer Mines Co. The last-named company sunk one winze from 276 feet to 302 feet and another from 290 to 330 feet, but the development of the ore found at that leval was discontinued until prices of concentrates were better. Two mills were operated during the first quarter of 1918 and one mill after that period.

The productive mines on leases in the immediate vicinity of Commerce on land of the Commerce Mining & Royalty Co., were the Cactus (Tango shaft), Lost Trail, Turkey Fat (The Concentrating Co.), and Miami Amalgamated (Sullivan). The Lennan mines on Commerce land at the northeastern limits of the town of Commerce, hoisted ore taken from levels as low as 375 feet, which was the deepest mining in the district. A small 75-ton mill was built at the New State mine by Homer Seals and good recoveries of galena and sphalerite were made from ore mined at the 110-foot level. Those mines situated in the new camps in the vicinity of Tar River, Picher, Douthat, St. Louis, and Hockerville, treated about 5,621,500 tons of crude ore, which yielded 68,437 tons of galena concentrates and 295,989 tons of sphalerite, an average recovery of 1.22 per cent in galena concentrates and 5.26 per cent in sphalerite concentrates and a total recovery of 6.48 per cent. As some of the large mines reported a recovery as high as 8 to 11 per cent, many of the mines must have treated ore that yielded only 3 to 4 per cent, or even less, in concentrates. It is difficult to segregate the producing mines according to camps, but most of the production in 1918 came from the vicinity of Picher, Tar Creek, and Douthat (Century), as the mines near St. Louis and Hockerville were developed last.

The total shipments of those properties, which may properly be classed as in the Tar River-Douthat area, of which there were a greater number than in the other areas, were 33,799 tons of galena and 164,394 tons of sphalerite. Slightly less than 3,155,000 tons of "dirt" was milled, so that the recovery in concentrate averaged about 6.28 per cent. A few of the mines yielded nearly as much galena as sphalerite, in a few mines the proportion of galena was as little as 1 per cent, and the proportion of galena to sphalerite on the whole was less than that recovered from the mines farther north. The largest output of galena was that of the O. M. Bilharz Mining Co. from the Shorthorn, Chapman, and Blue Bird mines, and shipments in excess of 1,000 tons were reported by the Oklahoma Woodchuck Zinc Lead Co., Laclede Lead & Zinc Co., Commerce Mining & Royalty Co. (Blue Goose), Robinson & Harvey (Central), Velie Mines Corp., Kitty Mining & Milling Co., Anna Beaver Mine, Admiralty Zinc Co. (mines 1, 2, 3, and 4), and the Skelton Lead & Zinc Co. The proportion of galena to sphalerite recovered at all the mines in the vicinity of Douthat was about 1 ton of galena to 12 of sphalerite, while in the Tar River section the mines yielded about 1 ton of galena to 3.3 tons of sphalerite.

The largest shippers of sphalerite in 1918 from the Tar River-Douthat section were the Skelton Lead & Zinc Co. (6 mills), the Admiralty Zinc Co. (4 mills), the Golden Rod Mining & Smelting Co. (4 mills), the Bethel Mining Co. (3 mills), O. M. Bilharz Mining Co. (3 mills), and the Montreal Mining Co., which had the largest output from a single property.

Other large shippers of sphalerite in 1918 were the Acme Lead & Zinc Co., Niangua Mining & Royalty Co., Oklahoma-Woodchuck Zinc Lead Co., Velie Mines Corporation (2 mills), John Skinner (Manhattan), Wingfield Mining Co., Larsh Lead & Zinc Co., Pioneer Lead & Zinc Co., Commerce Mining & Royalty Co. (Jay Bird, Benny, and Blue Goose mines), Kitty Mining & Milling Co., Lucky Junction Mining Co., Harrisburg Mining & Smelting Co., U. S. Mining & Smelting Co., Standard Zinc Lead Mining Co., Dorothy Bill Mining Co., Vinegar Hill Zinc Co. (Wilson mine), Goodeagle Mining Co., Sinden Zinc Co., Anna Beaver Mine (2 mills), Underwriters Land Co. (No. 1 mine), Ramage Mining Co. (No. 1 mine). Smaller and more recently developed producing properties were the Fort Worth, Quebec, Douthat, Lucky Kid, Greening, Waxahachie, Federal, Dallas-Miami, Victory, and Lucky Bill.

The new concentrating plants completed or under construction in 1917 were the Blue Bird, Wingfield, Benny, Harrisburg No. 2, Dorothy Bill, Anna Beaver No. 2, Alexander, Dallas-Miami, F. & F., Greening, Waxahachie, Skelton No. 7, Quebec, Century, and Maurine.

The territory lying east of Picher near the Hockerville and St. Louis camps was one of the most actively developed areas in the Miami district. Five mines produced 120 tons of galena and 3,859 tons of sphalerite in 1917. In 1918 the shipments from 14 mines were 1,438 tons of galena and 29,646 tons of sphalerite, which was recovered from approximately 348,000 tons of crude ore. The sphalerite averaged more than 60 per cent of zinc content and the output of galena was proportionately much less than in other parts of the Miami district.

Most of the milling plants were not operated steadily in 1918 and more than two-thirds of all the concentrates shipped was from the St. Louis and Huttig mines. More than 50 per cent of all the crude ore hoisted was treated in the two 400-ton mills of the St. Louis Smelting & Refining Co., which are among the best in the district. Dirt was hoisted through four shafts from levels between 232 and 245 feet and in addition to active work on the property of St. Louis several leases lying east of Hockerville were drilled and shafts were sunk. On the lease of the Huttig Lead & Zinc Co., on the Brewster land, ore was mined at the 225 to 265 foot levels which yielded more than 11 per cent in concentrates at the 300-ton mill. Other producers near St. Louis and Hockerville in 1918 were the Cosmos, Rainbow, Farmington, Golden Eagle, Homestake, Blue Bonnet, Choctaw Chief, Santa Fe, Black Eagle, and Indian Queen. New mills were completed or were under construction by the Federal Mining & Smelting Co. (Brewster mine) and the Mary Ann Mining Co.

The production of the mines in the vicinity of Picher showed a large increase in 1918. In 1917 the total quantity of ore milled was 947,800 tons, and 8,016 tons of galena and 44,964 tons of sphalerite concentrates were shipped. In 1918 the quantity of ore milled was

2,118,900 tons and 33,200 tons of galena, and 101,949 tons of sphalerite were shipped, which indicates a recovery of approximately 6.38 per cent in concentrates, of which one-fourth was galena. Most of the output was that of the Eagle Picher Lead Co., which operated the Whitebird, Bingham, Crawfish, Netta, Goodwin, Perin, Swift, Lasalle, and Potter mills. The production of both galena and sphalerite by this company was much larger than that of any other operator in the Miami district. Flotation units have been installed at nearly all the above-named plants and the concentrates recovered by that process has materially added to the output. The estimated capacity of the concentrating plants is now about 6,400 tons in 24 hours, and the ore mined is mainly derived from levels between 250 and 270 feet. In addition to the output of the mines and mills operated by this company there was a large production from ground subleased to the Vantage Mining Co., St. Joe Mining Co., Piokee Mining Co., Dewdrop Mining Co., Big Chief Mining Co., National Lead & Zinc Co., Ohimo Mining Co., Victor Mining Co., Keltner Mining Co., William F. White Mining Co., and other leases. The next largest producer of sphalerite was the Underwriters Land Co., which opened two very rich properties on the Whitebird land in 1918 known as Underwriters 2 and 3. The ore which yielded about 12 per cent in high-grade concentrates was mined at levels between 230 and 246 feet. The capacity of the mills on the lease is 550 tons and flotation units were added to both plants in 1918.

The Mahutska Mining Co. was a large producer of both galena and sphalerite. Three shafts were used in 1918 and the milling plant has a capacity of 500 tons. The Piokee, Dewdrop, Vantage, and White leases had a good output, although the plants were shut down in the latter part of 1918. The St. Joe mine on a Picher lease is equipped with a 400-ton mill, which produced a large quantity of concentrates in which lead predominated. The Chicago-Miami mine had a good output of both galena and sphalerite for its first year of operation. The mill has a capacity of 300 tons. A new 250-ton mill was built by the Ohimo Mining Co. and two shafts were sunk on a Picher lease in 1918. The crude ore mined at levels between 220 and 265 feet gave a recovery of 10 per cent in concentrates. The Big Chief mine yielded a large quantity of sphalerite, but the recovery of galena was comparatively small. The Keltner Mining Co. erected a 400-ton concentrating plant on the Picher lease of the Whitebird land in 1918 which was in operation the last half of the year. One of the largest producers in the southwestern part of the Picher camp was the Hare Mining & Milling Co. Two of the largest and most profitable mines in the Picher camp were the Premier and the New Chicago under the management of A. M. Gaines, both mines are equipped with complete concentrating plants.

The Producers Lead & Zinc Co. made a large production of concentrates at a 300-ton mill built in 1918. The following properties were operated and concentrates were shipped in 1918—the Grace Walker (owned by the Commerce Mining & Royalty Co.), the Victor (old Commonwealth), Black Hawk, Constitutional, Missouri Mule, Miami Wonder, Zinc Lead Corporation, Buelah B., and Royal. New concentrating plants were erected in 1918 by the Zinc Lead Corporation, Beulah B. Mining Co., Lasalle Mining Co., Black Hawk Lead & Zinc Co., the Lawyers Mining Co., and the Pelican mill of the Commerce Mining & Royalty Co. It is probable that in 1918 more shafts were sunk and more milling plants erected in the Miami district and its northerly extension in Kansas than in all the other mining districts west of the Mississippi.

WISCONSIN.

By J. P. Dunlop.

PRODUCTION.

Mine production of lead and zinc in Wisconsin in 1918.

District.	Ores.						Metal content.[a]			
	Lead concentrates.		Zinc concentrates.				Lead.		Zinc.	
	Galena.		Sphalerite.		Silicate and carbonate.					
	Quantity. (short tons).	Value.	Quantity. (short tons).	Value.	Quantity. (short tons).	Value.	Quantity. (short tons).	Value.	Quantity (short tons).	Value.
Benton-New Diggings	3,444	$278,684	104,180	$2,915,770	1,052	$29,879	2,493	$354,006	31,773	$5,782,686
Cuba City	223	20,334	2,210	40,632	......	......	175	24,850	421	76,622
Dodgeville	68	5,316	1,648	39,802	......	......	52	7,384	427	77,714
Hazel Green	35	1,875	6,817	180,700	......	......	20	2,840	1,698	309,036
Highland	138	11,203	3,514	92,417	3,939	84,447	105	14,910	1,820	331,240
Linden	373	30,659	5,417	111,475	......	......	285	40,470	1,447	263,354
Livingston	627	47,333	23,933	457,531	......	......	413	58,646	4,648	845,936
Mifflin	171	14,925	8,666	150,812	......	......	132	18,744	1,675	304,850
Mineral Point Montfort	33	2,640	110	2,700	224	3,304	25	3,550	85	15,470
Platteville and Potosi	126	10,522	6,879	199,663	......	......	100	14,200	2,227	405,314
Shullsburg	972	78,410	11,965	316,136	......	......	733	104,086	3,793	690,326
	6,210	501,901	175,339	4,507,638	5,215	117,630	4,533	643,686	50,014	9,102,548
Total, 1917	5,544	532,581	223,916	6,602,717	2,300	67,834	4,139	711,908	59,742	12,187,368

[a] In calculating the metal content of the ores for assays allowance has been made for smelting losses in the case of zinc but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead is calculated from the average sales price of all grades. The price of zinc for 1917 and 1918 is the average sales price of all grades reported by smelters.

Tenor of lead and zinc ore and concentrates produced in Wisconsin, 1917 and 1918.

	1917	1918
Total crude ore.....short tons..	3,014,800	2,377,300
Total concentrates in crude ore:		
Lead.....per cent..	0.18	0.26
Zinc.....do....	7.42	7.60
Metal content in crude ore:		
Lead.....do....	.13	.19
Zinc.....do....	2.44	2.61
Average lead content of galena concentrates.....do....	74.7	73.0
Average zinc content of sphalerite concentrates.....do....	32.8	34.6
Average zinc content of zinc carbonate concentrates.....do....	26.7	27.7
Average value per ton:		
Galena concentrates	$96.06	$80.82
Sphalerite concentrates	$29.48	$25.70
Zinc carbonate concentrates	$29.49	$22.56

The lead and zinc mines of Wisconsin are in Grant, Iowa, and Lafayette counties and comprise the most important part of the ore deposits of the upper Mississippi Valley region, a historical review of which is given in the Illinois secton of this report in Mineral Resources for 1914. A detailed description of the Wisconsin load and zinc districts and of the mines in each district to the year 1906 is given by Bain.[1]

Although mining development has continued and many new mines have been opened, worked out, and abandoned, the area of the mining region has not been enlarged to any extent. The development of the mines subsequent to Bain's report and the output of Wisconsin mines have been given in the reports in Mineral Resources of the United States for the years 1907 to 1916.

The ore deposits occur in the Galena dolomite and in the upper part of the Platteville limestone, both of Ordovician age. The ores are galena, sphalerite or zinc blende, with smithsonite or zinc carbonate, the last locally known as "dry bone." As a lead region the district has been known from the earliest settlement days. In time the building of smelters near by made a market for the zinc ores. The first zinc ore to be mined was the carbonate found in association with lead in the shallow working above ground-water level. When all the main deposits were worked out down to water level there was a lull in mining in the region. Though the carbonate was known to give place to zinc blende and the lead to continue on below water, it was not deemed profitable to mine when continued pumping was necessary. About 1900 the higher price of zinc led to the opening of some of the deposits below water level, since which time zinc mining has increased until Wisconsin ranks among the largest of the zinc-producing States. The ore bodies are found in perpendicular, horizontal, or inclined cavities known as "openings" or "crevices," "flats," and "pitches." The openings sometimes extend for a considerable distance in a straight line called a "range," and may be mined at different places by different companies. When a range is once established it becomes an important guide in prospecting.

The galena of the district is nonargentiferous, and so far as known the zinc ores are free from cadmium. In some of the mines marcasite is so plentiful that the zinc blende concentrates are reduced to a very low grade. Owing to their nearness in specific gravity, marcasite and blende are very difficult to separate cleanly by hydraulic methods.

Roasting and electromagnetic separation have been utilized in the district for many years—and especially in the last four years—to produce a marketable zinc product. The green sulphide concentrates are roasted in cylindrical roasters to drive off a little sulphur and render the iron sulphide magnetic, after which they are treated on electromagnetic separators and yield blende concentrates assaying from 56 to more than 60 per cent and pyrites tailings, which are purchased by manufacturers of sulphuric acid. Comparatively few of the concentrating plants are equipped with roasters, but practically all the larger mining interests own or control separating plants.[2]

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[1] Bain, H. F., Zinc and lead deposits of the upper Mississippi Valley: U. S. Geol. Survey Bull. 294, pp. 81–148, 1906.

[2] Deutman, E. G., The roasting and magnetic separation of Wisconsin zinc ores: Eng. and Min. Jour., June 28, 1919, pp. 1107–1111.

The roasting and separating plants operated in 1918 were those of the Mineral Point Zinc Co., at Mineral Point; the Champion plant of the Wisconsin Zinc Co., at New Diggings; the National Zinc Separating Co. and the Linden Zinc Co., at Cuba City; the Benton Roaster Co., at Benton; the Blockhouse Mining Co., at Platteville; and the Oliver Iron Mining Co., at Shullsburg, in Wisconsin.

There were approximately 188,500 tons of sphalerite concentrates shipped in 1918 from mines in the upper Mississippi Valley region, and of this quantity about 160,000 tons were treated at roasting and separating plants in Wisconsin. Eighty per cent of the raw concentrates were treated at three plants controlled by interests affiliated with the largest producers in the region—the Mineral Point Zinc Co., Wisconsin Zinc Co., and Vinegar Hill Zinc Co.

A Wedge furnace having a capacity of 250 tons in 24 hours was added to the National plant at Cuba City, and a new kiln was added to the equipment of the Linden Zinc Co. at Cuba City.

Two sulphuric-acid plants, one located adjoining the National plant at Cuba City and the other near the Champion roaster at New Diggings, which were designed to make use of the sulphur content of raw sphalerite ore treated at the roasters, were under construction in 1918. Neither plant was completed, as instructions were given by the Government to stop work on them shortly after the armistice was declared. It is not probable that the acid plants will be operated unless they are taken over by interests now engaged in roasting zinc ores in Wisconsin.

The average zinc content of the raw sphalerite concentrates sold in 1918 was 34.6 per cent and the average price per ton was $25.70; the corresponding content and price for 1913 were 38 per cent and $21.53; for 1914, 35.05 per cent and $17.73; for 1915, 36.5 per cent and $38.37; for 1916, 34.4 per cent and $36.75; and for 1917, 32.8 per cent and $29.48.

The percentage of concentrates recovered from crude ore is much higher than in the Joplin region, but the zinc concentrates average 21 to 25 per cent less in zinc content. On account of these conditions, at many mines no close recovery is made and the tailings are seldom reworked. The new concentrating plants, however, are equipped with more tables than formerly. The concentrates from the tables have a very high iron content, but this can be remedied by roasting.

The crude ore yields from 5 to more than 20 per cent of concentrates. The average recovery in concentrates increased from 7.60 per cent in 1917 to 7.86 per cent in 1918, which was a natural reflection of the lower price of sphalerite concentrates. The mining methods are largely determined by the mode of occurrence of the ores, but otherwise are similar to those in vogue in working the pockety ores at Joplin. The milling methods used in the Wisconsin field have been given by Walter Schultz,[1] of the Wisconsin Zinc Co.

The zinc-carbonate ore, which is mined principally in the Highland, Benton, and Mineral Point districts, is purchased mainly by the Mineral Point Zinc Co., and made into zinc oxide in the plant at Mineral Point, Wis.

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[1] Schultz, Walter, Milling Wisconsin lead-zinc ores: Eng. and Min. Jour., July 14, 1917, pp. 82–84.

The metal content of the raw sphalerite concentrates sold by the mines varied in 1917 from 18 to 56 per cent. The larger portion of the concentrates sold ranged between 28 and 38 per cent. The zinc content of the roasted sphalerite concentrates shipped varied from 55.5 to 61.3 per cent.

The value of the mine output of lead and zinc in Wisconsin for the year 1918 was $9,746,234, against $12,899,276 in 1917, a decrease of $3,153,042.

The lead concentrates sold increased from 5,544 tons, valued at $532,581, in 1917, to 6,210 tons, valued at $501,901, in 1918. The sphalerite concentrates sold decreased from 223,916 tons to 175,339 tons, and their value decreased from $6,602,717 to $4,507,638.

The quantity of zinc-carbonate concentrates shipped increased from 2,300 tons in 1917 to 5,215 tons in 1918, and the value from $67,834 to $117,630.

The metal content of the lead concentrates in 1918 was 394 tons more than in 1917. The recoverable zinc content of the sphalerite and zinc-carbonate concentrates in 1918 decreased 9,728 tons.

Fifty-eight milling plants were in operation during 1918, but a large part of these plants were idle at the end of the year. Six concentrating plants were constructed or rebuilt in 1918, namely, Lucky Six No. 2 at Linden, Connecting Link and Little Dick at Cuba City, Little Platte at Platteville, Dale Rundell at Livingston, and the Copeland at Shullsburg. The Zinc Hill Mining Co. was rebuilding the mill purchased from the Spring Hill Mining Co., of Linden, at a new lease near Cuba City. Very little development was done in 1918, and very few new mines were opened. As in all other mining regions during 1918, labor was scarce until December, and costs of mining and milling increased to such an extent that many of the small operators suspended work.

From an article comparing the costs of mining and milling zinc ores in Wisconsin in 1918 with similar operating expenses in 1914, prepared by W. F. Boericke, and published in the Engineering and Mining Journal on March 29, 1919, the following extracts are taken:

> The unit costs have increased 55.1 per cent over those of 1914. Applying these figures concretely, it is patent that if the working cost per ton of mine "dirt" in 1913 was $1, a result generally obtained by the large operators who were working on a tonnage of over 10,000 tons a month, the cost in December, 1918, for the same amount of labor, supplies, powder, and power, would be $1.55 per ton. If the mines were then making a 10 per cent recovery of concentrate in the mill, the cost per ton of concentrate would in 1913 have been $10. In 1918, with the same recovery, it would be $15.51.
>
> Under these conditions the operators have four possible sources for relief: First, a reduction in unit costs to pre-war figures, through reduction in wages and prices; second, a rise in the price received for concentrates that will compensate for the increased costs; third, an increase in the efficiency of mining methods which will offset the increased wages to labor by yielding a larger tonnage per man; fourth, to raise the grade of the ore by mining richer ground, thus increasing the mill recovery at the expense of the mine, and so lowering the cost of making concentrates.
>
> It is questionable, however, if there is any conviction among operators that a radical reduction in wages should be made at the present time. In common with the general sentiment of business throughout the country it is felt that wages are not out of proportion to the cost of living and that any marked reduction would result in considerable hardship and ill feeling. But a readjustment in general wages is likely to occur in the near future, unless ore prices should advance.

There is no doubt that good work has been done in power economy, by closer adjustment and alinement of machinery, and better inspection generally; but the total saving, in comparison with the other factors of the cost sheet, is small. The operators, therefore, generally have been obliged to resort to mining richer ground; and by thus increasing mill recovery they have kept the concentrate cost from rising in the same marked degree as the working cost. Where this has been impossible on account of the nature of the ore deposit the usual policy has been to close the mine rather than to exhaust ore reserves on an unprofitable market.

Although present conditions in the district are depressing, it is believed, with reason, that much can be done in the matter of decreasing costs, even on the present wage scale. The attitude of the men generally is good, and it is thought that they will enter heartily into anything that will help keep the mines above water. Some assistance is expected from lower prices for powder and supplies. The operators feel that they have demonstrated in the past their ability to work ground at as low a cost as has been possible in any other zinc district, and with a turn in the market it is probable that production will again reach a high figure.

The larger mining interests in the Wisconsin field, which include the Mineral Point Zinc Co., Wisconsin Zinc Co., Vinegar Hill Zinc Co., Frontier Mining Co., and Field Mining & Milling Co., had a combined output approximately equal to 64 per cent of all the lead concentrates and 76 per cent of all the zinc concentrates shipped from Wisconsin mines in 1918. Mines controlled by the Laurence Mines Co., Blockhouse Mining Co., M. & A. Mining Co., and the Oliver Iron Mining Co. contributed substantially to the output in 1918.

For descriptions of the old mines and concentrating plants on which no essential changes were made during 1918, the reader is referred to the corresponding section of this report in Mineral Resources for 1914, 1915, 1916, and 1917.

The Benton-New Diggings district produced about 55.5 per cent of the galena, 20 per cent of the zinc carbonate, and nearly 60 per cent of the sphalerite shipped from Wisconsin in 1918. Its output was nearly 4½ times that of Livingston, the next largest producing district. The districts in Wisconsin that had a larger production of zinc concentrates in 1918 than in 1917 were Cuba City, Highland, and Shullsburg. The quantity of ore treated was about 637,500 tons less in 1918 than in 1917, and the quantity of green sphalerite concentrates recovered was 22 per cent less than in 1917. The average zinc content increased from 32.8 per cent in 1917 to 34.6 per cent in 1918.

The shipments from the Benton part of the Benton-New Diggings district in 1918 were 787 tons of galena and 30,298 tons of sphalerite, a decrease of about 50 per cent. The shipments from New Diggings camp were 2,657 tons of galena, 73,882 tons of sphalerite, and 1,052 tons of zinc carbonate.

Notwithstanding the large decrease in the total production of lead and zinc concentrates in Wisconsin in 1918 the shipments from mines at New Diggings increased by 1,377 tons of galena, 24 tons of sphalerite, and 787 tons of zinc carbonate.

The Hoskins mine of the Mineral Point Zinc Co., located at New Diggings, which was opened in 1917, was the largest producer in Wisconsin of both galena and sphalerite in 1918, and the Champion mine of the Wisconsin Zinc Co. had the second largest output of sphalerite. The other large producing properties at Benton-New Diggings in 1918 were the Longhorn and C. A. Thompson mines of the Wisconsin Zinc Co., the Meloy, Blackstone, Martin, and Kittoe mines of the Vinegar Hill Zinc Co., the Crahall of the Field Mining & Milling Co., the Penna-Benton of the Mineral Point Zinc Co., the Indian Mound of the Laurence Mines Co., the Bearcat, Middi, and Robson mines of the Frontier Mining Co., and the Ida Blende Mining Co. Some galena concentrates and all the zinc carbonate concentrates were shipped by the Maude Mining Co., Robson Mining Co., the P. S. & H. Mining Co., and the Acker Mining Co.

The Fox mine and the Burr mines, which were operated part of the year, were abandoned and the milling plants were removed.

Most of the production in the Cuba City district in 1918 was that of the Connecting Link Mining Co., which has a 150-ton mill on the Dall land and is building another mill on the Coulthard land. The C. H. & S. Mining Co. and the Zinc Hill Mining Co. shipped galena and sphalerite in 1918, but both were idle in December. Small shipments of concentrates were made from the Dodgeville district by Evans Bros., Carroll Guthrie, and the Lucky Five Mining Co., but most of the output was that of the North Survey Mining Co.

The producing mines in the Hazel Green district were the Kennedy, Monmouth, and Jefferson. The old Kennedy mine produced most of the sphalerite. The mill at the Monmouth was started in August, 1918, after considerable additions had been made to the surface equipment.

The only large shippers in the Highland district were the Highland and the Lampe mines. Only one milling plant was operated by the Mineral Point Zinc Co., and most of the ore shipments were of crude zinc carbonate sent to the oxide plant at Mineral Point.

The production of the Linden district in 1918 was much less than in 1917, and nearly all the mines were closed before the end of the year. The Optimo mine, which was the largest producer, has been subleased to the Vinegar Hill Zinc Co. The other mines which produced concentrates in 1918 were the Ross, Stoner, Launder, Milwaukee-Linden, and Lucky Six. The only new mill erected in the district was Lucky Six No. 2, on the Heathcock land, where a shaft was sunk and considerable drifting done.

The shipment of sphalerite from the Livingston district in 1918 was 23,933 tons, 2,637 tons less than in 1917. The only producing mines were Coker No. 1 and Coker No. 2 of the Mineral Point Zinc Co. and the Yewdall mine of the Vinegar Hill Zinc Co.

From mines in the Mifflin district 171 tons of galena and 8,666 tons of sphalerite concentrates were shipped in 1918, which was about 42 per cent less than in 1917. The output was that of the M. & A., Grunow, Peacock, Lucky Six No. 1, B. M. & B., Wickes, and Billings mines. The only new mill erected in 1918 was that at the Dale Rundell mine owned by the Vinegar Hill Zinc Co. This plant, which has a capacity of 30 tons an hour, was not operated in 1918.

There was very little mining near Mineral Point in 1918, and the only concentrates shipped were purchased from scrappers.

Mines in the Platteville and Potosi districts produced 126 tons of galena and 6,879 tons of sphalerite in 1918, nearly all of which was shipped by the Blockhouse Mining Co. and the New Rose Mining Co. Smaller shippers were the Potosi Mining Co., the M. & H. Mining

Co., and the Little Platte Mining Co. The M. & H., the New Empire, and the New Rose Mining Co. closed their plants before December, 1918, and the Potosi mine was worked only for about six weeks.

The production of both galena and of sphalerite from mines in the Shullsburg district in 1918 was double that of 1917. The Paquette Mining Co. and John McCullough shipped some concentrates, but nearly all the shipments were those of the Oliver Iron Mining Co., Rodham McQuitty Mining Co., and the Wisconsin Zinc Co. (Copeland mine). The Copeland mine and 150-ton mill was steadily operated and drilling located some ore bodies which will be developed when prices for sphalerite warrant the expense. The Paquette Mining Co. sunk a 110-foot shaft and shipped some galena which was recovered in driving a 100-foot drift at the 90-foot level. A concentrating plant was purchased, but was not erected in 1918.

UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS ON GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE CENTRAL STATES.[1]

ADAMS, G. I., Zinc and lead deposits of northern Arkansas: Bull. 213, pp. 187–196, 1903. 25 cents.

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BAIN, H. F., Lead and zinc deposits of Illinois: Bull. 225, pp. 202–207, 1904. 35 cents.

——— Lead and zinc resources of the United States: Bull. 260, pp. 251–273, 1905. 40 cents.

——— Zinc and lead ores in 1905: Mineral Resources U. S. for 1905, pp. 379–392, 1906. $1.

——— Zinc and lead deposits of northwestern Illinois: Bull. 246, pp. 56, 1905. 15 cents.

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BAIN, H. F., and ULRICH, E. O., The copper deposits of Missouri: Bull. 260, pp. 233–235, 1905. 40 cents.

BUTLER, B. S., and SIEBENTHAL, C. E., Silver, copper, lead, and zinc in the Central States in 1909 (mine production): Mineral Resources U. S. for 1909, pt. 1, pp. 495–531, 1911. 60 cents.

BUTLER, B. S., and DUNLOP, J. P., Silver, copper, lead, and zinc in the Central States in 1910 (mine production): Mineral Resources U. S. for 1910, pt. 1, pp. 611–674, 1911. 75 cents.

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——— Idem for 1913, pp. 81–171, 1914. 70 cents.

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CLERC, F. L., The mining and metallurgy of lead and zinc in the United States: Mineral Resources U. S. for 1882, pp. 358–386, 1883. 50 cents.

DUNLOP, J. P., and BUTLER, B. S., Silver, copper, lead, and zinc in the Central States in 1915 (mines report): Mineral Resources U. S. for 1915, pt. 1, pp. 45–137, 1917. See also Butler, B. S., and Dunlop, J. P.

——— Idem for 1916, pp. 53–157, 1917.

——— Idem for 1917, pp. ——.

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[1] The publications for which a price is given are no longer available for free distribution but can be purchased from the Superintendent of Documents, Washington, D. C.; others can be obtained free on application to the Director of the United States Geological Survey. Some are out of print but may be examined in libraries.

Ellis, E. E., Zinc and lead mines near Dodgeville, Wis.: Bull. 260, pp. 311–315, 1905. 40 cents.

Grant, U. S., Zinc and lead deposits of southwestern Wisconsin: Bull 260, pp. 304–310, 1905. 40 cents.

Grant, U. S., and Burchard, E. F., Geol. Atlas, Lancaster-Mineral Point folio (No. 145), 1907. 5 cents.

Irving, R. D., The copper-bearing rocks of Lake Superior: Mon. 5, 464 pp., 1883. $1.85.

Lindgren, Waldemar, Resources of the United States in gold, silver, copper, lead, and zinc: Bull. 394, pp. 114–156, 1909. 40 cents.

——— Tests for gold and silver in shales from western Kansas: Bull. 202, 21 pp., 1902. 5 cents.

Siebenthal, C. E., Mineral resources of northeastern Oklahoma: Bull. 340, pp. 187–228, 1908. 30 cents.

——— Origin of the zinc and lead deposits of the Joplin region, Missouri, Kansas, and Oklahoma: Bull. 606, 283 pp., 11 pls., 1915. 25 cents.

Smith, W. S. T., Lead and zinc deposits of the Joplin district, Missouri-Kansas: Bull. 213, pp. 197–204, 1903. 25 cents.

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Van Hise, C. R., and Leith, C. K., The geology of the Lake Superior region: Mon. 52, 1911. $2.50.

Winslow, Arthur, The disseminated lead ores of southeastern Missouri: Bull. 132, 31 pp., 1896. 5 cents.

GOLD, SILVER, COPPER, AND LEAD IN ALASKA.

(MINES REPORT.)

By G. C. Martin.

INTRODUCTION.[1]

The mineral production of Alaska in 1918, including the metals besides gold, silver, copper, and lead, was valued at about $28,300,000. This output was almost $11,700,000 less than that for 1917 and was the smallest since 1914. The decrease was chiefly in copper, the production of which fell from 88,793,400 pounds, valued at $24,240,598, in 1917 to 69,224,951 pounds, valued at $17,098,563, in 1918. The reduction in the output of copper was due to shortage of labor and ships. The production of gold decreased from 709,049 ounces, valued at $14,657,353, in 1917 to 458,641 ounces, valued at $9,480,952, in 1918 and was the smallest since 1904. The reduction in the output of gold was due chiefly to scarcity of labor and high cost of materials. There was a reduction in the output of silver and lead, consequent upon the decrease in production of gold and copper.

PRODUCTION.

The following table gives an estimate of the total production of gold, silver, copper, and lead in Alaska since the beginning of mining in 1880. For the earlier years, the figures, especially for the silver, are probably far from being correct, but they are based on the best information now available.

Gold, silver, copper, and lead produced in Alaska, 1880–1918.

Year.	Gold.		Silver.		Copper.		Lead.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.	Quantity (pounds).	Value.	Quantity. (short tons).	Value.
1880	967	$20,000	10,320	$11,146	3,933	$826	....	....
1881	1,935	40,000					....	....
1882	7,256	150,000					....	....
1883	14,561	301,000					....	....
1884	9,724	201,000					....	....
1885	14,512	300,000					....	....
1886	21,575	446,000					....	....
1887	32,653	675,000					....	....
1888	41,119	850,000	2,320	2,181	....	....	....	....
1889	43,538	900,000	8,000	7,490	....	....	....	....
1890	36,862	762,000	7,500	6,071	....	....	....	....
1891	43,538	900,000	8,000	7,920	....	....	....	....
1892	52,245	1,080,000	8,000	7,000	....	....	30	$2,400

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[1] The data on mining conditions and production here given are abstracted from a paper by G. C. Martin, to be published in U. S. Geol. Survey Bulletin 712. Mr. Martin was assisted in the statistical work by T. R. Burch. The original paper and the papers that accompany it treat the subject at greater length than is desired here and they should be consulted by those who require the more detailed information.

Gold, silver, copper, and lead produced in Alaska, 1880–1918—Continued.

Year.	Gold.		Silver.		Copper.		Lead.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.	Quantity (pounds).	Value.	Quantity (short tons).	Value.
1893	50,213	$1,038,000	8,400	6,570			40	3,040
1894	62,017	1,282,000	22,261	14,257			35	2,310
1895	112,642	2,328,500	67,200	44,222			20	1 320
1896	138,401	2,861,000	145,300	99,087			30	1,800
1897	118,011	2,439,500	116,400	70,741			30	2,160
1898	121,760	2,517,000	92,400	54,575			30	2,240
1899	270,997	5,602,000	140,100	84,276			35	3,150
1900	395,030	8,166,000	73,300	45,494			40	3,440
1901	335,369	6,932,700	47,900	28,598	250,000	$40,000	40	3,440
1902	400,709	8,283,400	92,000	48,590	360,000	41,400	30	2,460
1903	420,069	8,683,600	143,600	77,843	1,200,000	156,000	30	2,520
1904	443,115	9,160,000	198,700	114,934	2,043,586	275,676	30	2,580
1905	756,101	15,630,000	132,174	80,165	4,805,236	749,617	30	2,620
1906	1,066,030	22,036,794	203,500	136,345	5,871,811	1,133,260	30	3,420
1907	936,043	19,349,743	149,784	98,857	6,308,786	1,261,757	30	3,180
1908	933,290	19,292,818	135,672	71,906	4,585,362	605,267	40	3,360
1909	987,417	20,411,716	147,950	76,934	4,124,705	536,211	69	5,934
1910	780,131	16,126,749	157,850	85,239	4,241,689	538,695	75	6,000
1911	815,276	16,853,256	460,231	243,923	27,267,878	3,408,485	51	4,590
1912	829,436	17,145,951	515,186	316,839	29,230,491	4,823,031	45	4,050
1913	755,947	15,626,813	362,563	218,988	21,659,958	3,357,293	6	528
1914	762,596	15,764,259	394,805	218,327	21,450,628	2,852,934	28	1,344
1915	807,966	16,702,144	1,071,782	543,393	86,509,312	15,139,129	437	41,118
1916	834,068	17,241,713	1,379,171	907,495	119,854,839	29,484,291	820	113,160
1917	709,049	14,657,353	1,239,150	1,021,060	88,793,400	24,240,598	852	146,584
1918	458,641	9,480,952	847,789	847,789	69,224,951	17,098,563	564	80,088
	14,620,809	302,238,961	8,389,308	5,598,255	497,786,565	105,743,033	3,497	449,436

GOLD AND SILVER.

The subjoined table gives an estimate, based on the best available data, of the source of the gold and silver produced in Alaska since mining began in 1880. About $65,900,000 worth of gold, or one-fifth of the total estimated output, was produced before 1905, and there is scant information as to its source. For the period since that time fairly complete statistical returns are available, and it is probable that the figures presented in the following table are sufficiently accurate to be valuable. The figures given for the silver recovered from placer gold and from siliceous ores are probably less accurate than those for the gold. Copper mining did not begin in Alaska until 1901, and the figures for gold and silver derived from this industry, as now presented, are therefore a close approximation to the actual output.

Gold and silver produced in Alaska, 1880–1918, by sources.

	Gold.		Silver.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.
Siliceous ores[a]	4,234,054	$87,525,670	1,319,889	$931,396
Copper ores	80,800	1,670,299	5,327,852	3,666,820
Placers	10,305,955	213,042,992	1,741,567	1,000,039
	14,620,809	302,238,961	8,389,308	5,598,255

[a] Including small quantities of lead ore.

This table shows that 29 per cent of the total production of gold in Alaska has been obtained from the auriferous lode mines (siliceous ores). In 1918 the production of lode gold was 36.6 per cent; in 1917, 31 per cent; in 1916, 34 per cent; in 1915, 36 per cent; in 1914, 31 per cent; in 1913, 31 per cent; and in 1912, 29 per cent. In the following table the production of precious metals in 1918 has been distributed as to sources:

Gold, silver, copper, and lead produced in Alaska, 1918, by sources.

Source.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Siliceous ores [a]	2,095,577	168,022	90,064	....	1,127,734
Copper ores [b]	722,047	5,207	719,391	69,224,951	....
Placers	....	285,412	38,334	....	....
	2,817,624	458,641	847,789	69,224,951	1,127,734

[a] Including a small quantity of lead ore, which can not be given separately without disclosing individual production.

[b] Including a small quantity of copper derived from placers.

LODE MINING.

Twenty-five lode-gold mines were operated in 1918. There was also a production from seven prospects, mines now abandoned or small mines that were not in regular operation. Thirty-one mines were operated in 1917. The value of the output of lode gold decreased from $4,581,453 in 1917 to $3,473,317 in 1918. The decrease was due partly to the disaster at the Treadwell mine in April, 1917, and partly to curtailment of operations, especially in the Juneau district, because of shortage of labor. Southeastern Alaska, especially the Juneau district, is still the only center of large quartz-mining operations in the Territory. Next in importance is the Willow Creek lode district. The production in the Fairbanks district decreased materially, as the owners of lode mines at Fairbanks are still awaiting the cheapening of operating costs, especially of fuel, which is expected on the completion of the Government railroad. Most of the gold mines on Prince William Sound have suspended operations. The mill and cyanide plant of the North Midas mine, in the Chitina Valley, Copper River district, was completed and began operating late in the year. Of the producing mines six were in southeastern Alaska, one in the Copper River district, three on Prince William Sound, four on Kenai Peninsula, five in the Willow Creek district, and six in the Fairbanks district. In 1918 the average value of the gold and silver contents of all siliceous ores mined was $1.70 a ton; the average for 1917 was $1.37 a ton. These averages reflect the dominance in the total lode production of the large quantity of the low-grade ores of the Juneau district.

The production by districts of gold and silver in 1918 from lode-gold mines, including a small output from a lead-silver mine which may not be given separately, is shown in the following table:

Production of gold and silver from gold-lode mines, by districts, 1918.

District.	Mines operated.	Ore mined (short tons.)	Gold.		Silver.		Average value per ton of ore in gold and silver.
			Quantity (fine ounces.)	Value.	Quantity (fine ounces.)	Value.	
Southern Alaska	[a] 6	2,085,915	152,756	$3,157,732	88,053	$88,053	$1.56
Prince William Sound [b]	[c] 4	444	638	13,195	490	490	[d] 27.24
Kenia Peninsula	4	207	291	6,016	181	181	29.94
Willow Creek	5	7,976	13,043	269,624	724	724	33.90
Fairbanks district [e]	[f] 6	1,035	1,294	26,750	616	616	26.44
	25	2,095,577	168,022	3,473,317	90,064	90,064	1.70

[a] Also clean up material from 2 abandoned mines and shipments from 1 prospect.
[b] Including 1 mine in Copper River district.
[c] Also 1 prospect.
[d] Prince William Sound only.
[e] Includes some lead ore.
[f] Also 3 prospects.

PLACER MINING.

The value of the placer gold produced in Alaska in 1918 was $5,900,000; in 1917 it was $9,810,000. The decrease in 1918 was general throughout the Territory, except in the Copper River, Yentna, and some of the smaller Yukon districts. The decrease was due to curtailment of operations because of shortage of labor, high cost of supplies, and uncertainty as to future conditions. Local decreases were due also to unfavorable climatic conditions and to the depletion of some of the richer placers.

It is estimated that 574 placer mines were operated in the summer of 1918 and 153 during the previous winter, but many for only a part of the season. About 3,000 men were engaged in productive placer mining in the summer and 613 in the winter. In addition, several hundred men were engaged in prospecting or other nonproductive work relating to placer mining. No important new placer-bearing areas were discovered in 1918. The output and operations of placer mines in 1918 are shown by regions in the following table:

Gold and silver produced from placer mines in Alaska, by regions, 1918.

Region.	Gold.		Silver.		Cubic yards of gravel.	Recovery per cubic yard.	Number of mines.		Number of miners.	
	Quantity (fine ounces.)	Value.	Quantity (fine ounces.)	Value.			Summer.	Winter	Summer.	Winter.
Southeastern Alaska	483.750	$10,000	80	$80	10,000	$1.00	5	......	12	......
Copper River region	11,561.625	239,000	1,158	1,158	198,000	1.20	22	4	124	7
Cook Inlet and Susitna region	7,740.000	160,000	1,185	1,185	386,000	.41	24	......	134	......
Southwestern Alaska	145.125	3,000	23	23	2,000	1.50	5	......	13	......
Yukon Basin	206,271.000	4,264,000	28,831	28,831	2,197,000	1.94	355	121	1,965	490
Kuskokwim region	4,837.500	100,000	914	914	56,000	1.78	19	......	87	......
Seward Peninsula	53,599.500	1,108,000	6,022	6,022	2,076,000	.53	128	21	633	99
Norton Sound	48.375	1,000	9	9	....	4.21	2	2	3	3
Kobuk region	725.625	15,000	112	112	6,000	2.50	14	5	35	14
	285,412.500	5,900,000	38,334	38,334	4,931,000	1.196	574	153	3,006	613

The following table shows approximately the total quantity of gravel mined annually and the value of gold recovered per cubic yard. The table is based in part on returns made by placer-mine operators and in part on known facts or assumptions concerning the richness of the gravels in the various districts. The figures for 1917, which differ somewhat from those previously published, are based on the assumption that the recoveries per cubic yard of the dredges in the Yukon region and Seward Peninsula that did not report their yardage were the same as the average reported recoveries of the dredges in each region, and that for the placer mines other than dredges the ratio of the recovery per cubic yard for the mines that supplied complete information to the recovery per cubic yard for all mines was the same as in 1916. Although the table is thus only approximately correct, the quantities stated are probably near the true figures.

Estimated quantity of gravel sluiced in Alaskan placer mines and value of gold recovered, 1908–1918.

Year.	Gravel sluiced (cubic yards).	Value of gold recovered per cubic yard.	Year.	Gravel sluiced (cubic yards).	Value of gold recovered per cubic yard.
1908	4,275,000	$3.74	1914	8,500,000	$1.26
1909	4,418,000	3.66	1915	8,100,000	1.29
1910	4,036,000	2.97	1916	7,100,000	1.57
1911	5,790,000	2.17	1917	7,000,000	1.40
1912	7,050,000	1.70	1918	4,931,000	1.20
1913	6,800,000	1.57			

This table shows that from 1908 to 1914 there was a decline in the average gold content of the gravels mined. This decline reflects the improved methods of placer mining that have been introduced, more especially the increase in the use of dredges, which is brought out in the following table:

Relation of recovery of placer gold per cubic yard to proportion produced by dredges.

	Percentage of placer gold produced by dredges.	Recovery per cubic yard.		
		Dredges.	Mines.	All placers.
1911	12	$0.60	$3.36	$2.17
1912	18	.65	2.68	1.70
1913	21	.54	3.11	1.57
1914	22	.53	2.07	1.26
1915	22	.51	2.33	1.29
1916	24	.69	2.64	1.57
1917	26	.68	2.21	1.40
1918	24	.57	1.84	1.20

The rise of the average recovery from 1914 to 1916 was due largely to the facts that the dredges were for the most part working on far richer placers than in previous years and that in 1916 a larger percentage of the placer gold came from the rich deposits of the newer districts. The decrease in the recovery per cubic yard from 1916 to 1918 is very striking. The yield per cubic yard for both the dredges and the other mines declined sharply, the proportionate output of the dredges remaining constant, but the recovery per cubic yard both for the mines other than dredges and for all the placers sunk to their lowest record. It seems surprising at first sight that this condition should exist at a time when the costs have increased so much that many mines have been compelled to suspend operations and when the Alaskan placer industry has declined to about half its normal magnitude. It might be expected that at such a time the poorer mines would close and that an increase in the average recovery would result. It is evident, however, that it is cost and not yield which determines whether a mine shall continue in operation. Under adverse conditions the small-scale, high-cost operations succumb first, even though they are working on high-grade deposits. The larger operations, which for the most part are working on lower-grade deposits, continue in operation longer because they are using machinery and practicing economics that permit them to survive the adverse conditions. Some of them are compelled to continue in operation, even at a loss, because they have rentals and other fixed charges which must be paid, machinery and other equipment which must be kept in continuous operation, or personal obligations to the community or to their employees which they can not ignore. The result is that under adverse conditions a larger proportion of the output of placer gold is derived from large, expensive operations such as dredges and large hydraulic plants which are working on relatively low-grade deposits. Such was the case in Alaska in 1918, when the districts in which there are large hydraulic plants working on low-grade gravels, such as the Yentna, Nizina, Chistochina, and upper Yukon districts, alone maintained or increased their customary output. Other factors that contributed to the low average recovery for 1918 include the relatively low recovery of the dredges, which was due in part to the unusually large amount of frozen ground encountered by dredges in Seward Peninsula and in part to the exhaustion of the relatively rich ground that had been dredged at Ruby in previous years and the exhaustion of some of the richer placers, especially in the Tolovana district.

Twenty-eight gold dredges were operated in Alaska in 1918, compared with 36 in 1917. Twenty-one dredges were in Seward Peninsula, three in the Iditarod district, and one each in the Fairbanks, Circle, Yentna, and Kuskokwim districts. These dredges produced about $1,425,000 worth of gold and handled about 2,490,000 cubic yards of gravel. In 1917 the 36 dredges handled about 3,700,000 cubic yards of gravel and recovered gold worth $2,500,000. The average recovery of gold per cubic yard was 57 cents in 1918 and 68 cents in 1917. The gold dredges of Seward Peninsula produced gold worth $466,000 from 1,164,000 cubic yards of gravel, an average recovery of 40 cents a cubic yard in 1918, compared with 49 cents in 1917. The dredges of the Alaska Yukon districts produced gold worth $881,000 from 1,125,000 cubic yards of gravel. The value of gold recovered per cubic yard in 1918 was 78 cents, compared with 94 cents in 1917.

Though dredges were built for use in the Alaska Yukon as early as 1898 and at Nome in 1900, this method of placer mining did not reach a profitable stage until 1903, when two small dredges were successfully operated in Seward Peninsula. Dredging began in the Fortymile district in 1907; in the Iditarod, Birch Creek, and Fairbanks districts in 1912; in the Yentna district in 1916; and in the Kuskokwim region in 1918. A new dredge was installed in the Fairbanks district in 1918 and may have begun operating late in the season. The new dredge on Candle Creek in the Kuskokwim region was completed in 1918 and operated for a short period. Up to the end of 1918 gold to the value of $19,035,000 has been mined by dredges. The distribution of this output by years is shown in the following table:

Estimate of gold produced from dredge mining in Alaska, 1903–1918.

Year.	Number of dredges operated.	Value of gold recovered.	Gravel handled (cubic yards).	Value of gold recovered per cubic yard.
1903	2	$20,000	....	....
1904	3	25,000	....	....
1905	3	40,000	....	....
1906	3	120,000	....	....
1907	4	250,000	....	....
1908	4	171,000	....	....
1909	14	425,000	....	....
1910	18	800,000	....	....
1911	27	1,500,000	2,500,000	$0.60
1912	38	2,200,000	3,400,000	.65
1913	35	2,200,000	4,100,000	.54
1914	42	2,350,000	4,450,000	.53
1915	35	2,330,000	4,600,000	.51
1916	34	2,679,000	3,900,000	.69
1917	36	2,500,000	3,700,000	.68
1918	28	1,425,000	2,490,000	.57
	....	19,035,000	....	....

COPPER.

The production of copper in Alaska in 1918 was 69,224,951 pounds, valued at $17,098,563. This is less than the production in 1917, which was 88,793,400 pounds, valued at $24,240,598. The reduction in output was due to shortage of labor and ships. During the year 17 copper mines were operated, the same number as in 1917. Of these mines, 7 are in the Ketchikan district, 5 in the Prince William Sound district, and 5 in the Chitina district.

Output of Alaska copper mines, by districts, in 1918.

	Number of mines.	Ore.	Copper.		Gold.		Silver.	
		Quantity (short tons).	Quantity (pounds).	Value.	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.
Ketchikan district	7	21,683	1,372,347	$338,970	1,364.51	$28,207	9,745	$9,745
Chitina[a]	5	264,538	52,541,014	12,977,630	....	....	591,317	591,317
Prince William Sound[b]	5	435,826	15,311,590	3,781,963	3,842.33	79,428	118,329	118,329
	17	722,047	69,224,951	17,098,563	5,206.84	107,635	719,391	719,391

[a] Also a small quantity of placer copper.

[b] Including a small output from Cook Inlet.

The average copper content of the ores mined in 1918 was 4.8 per cent. The ores also yielded an average of $0.149 in gold and $0.996 in silver per ton. The average yield for 1917 was 6.7 per cent of copper, $0.40 to the ton in gold, and $1.30 to the ton in silver. The following table shows the total production of copper in Alaska by years:

Copper produced in Alaska, 1880–1918.

Year.	Ore mined (short tons).	Copper produced.	
		Quantity (pounds).	Value.
1880	[a] 40,000	3,933	$826
1901		250,000	40,000
1902		360,000	41,400
1903		1,200,000	156,000
1904		2,043,586	275,676
1905	52,199	4,805,236	749,617
1906	106,729	5,871,811	1,133,260
1907	98,927	6,308,786	1,261,757
1908	51,509	4,585,362	605,267
1909	34,669	4,124,705	536,211
1910	39,365	4,241,689	538,695
1911	68,975	27,267,878	3,408,435
1912	93,452	29,230,491	4,823,031
1913	135,756	21,659,958	3,357,293
1914	153,605	21,450,628	2,852,934
1915	369,600	86,509,312	15,139,129
1916	617,264	119,854,839	29,484,291
1917	659,957	88,793,400	24,240,598
1918	722,047	69,224,951	17,098,563
	3,243,054	497,786,565	105,743,033

[a] Estimated.

The copper industry in the three developed copper fields of Alaska is described on subsequent pages. The only shipment of copper ore in 1918 from outside these developed fields was a test shipment from Kamishak Bay, Cook Inlet. A copper prospect on the Alaska Peninsula is under development, and interest still continues in the copper deposits of the Talkeetna and Broad Pass districts. The copper deposits recently reported in the Alaska Range are still attracting attention, although little work has been done on them. The deposit of copper discovered three years ago on Rainy Creek, a tributary of the south fork of Delta River, 7 miles above Miller's roadhouse, is said to be a large body of low-grade ore on which considerable crosscutting has been done. There is also a low-grade copper deposit in the gulch 1½ or 2 miles west of Paxson's roadhouse. A copper lode on McLaren River, tributary to the Susitna, is said to be 10 feet wide and of high grade. It was reported that an outfit was to be taken in on the snow in the winter of 1918–19 to prospect this deposit.

LEAD.

The production of lead in Alaska in 1918 is estimated at 564 short tons, valued at $80,088. The production of 1917, which was larger than that of any previous year, was 852 tons, valued at $146,584. Lead in Alaska is still, as in past years, derived chiefly from the concentrates of the gold mines at Juneau. The production of lead in 1918 includes a small quantity derived from the galena ores of the Fairbanks district. Though silver-lead ores are found in many parts of Alaska, most of the deposits have not yet been opened on a commercial basis. The following table shows the production of lead in Alaska, so far as it can be determined from available data:

Lead produced in Alaska, 1892–1918.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1892	30	$2,400	1906	30	$3,420
1893	40	3,040	1907	30	3,180
1894	35	2,310	1908	40	3,360
1895	20	1,320	1909	69	5,934
1896	30	1,800	1910	75	6,660
1897	30	2,160	1911	51	4,590
1898	30	2,240	1912	45	4,050
1899	35	3,150	1913	6	528
1900	40	3,440	1914	28	1,344
1901	40	3,440	1915	437	41,118
1902	30	2,460	1916	820	113,160
1903	30	2,520	1917	852	146,584
1904	30	2,580	1918	564	80,088
1905	30	2,620			
				3,497	449,436

REVIEW BY DISTRICTS.

SOUTHEASTERN ALASKA.

Six gold lode mines, seven copper mines, and several small placer mines were operated in southeastern Alaska in 1918. The value of the mineral production of these mines was: Gold, $3,195,939; copper (1,372,347 pounds), $338,970; silver, $97,878; and lead, $79,654. The largest mining operations in southeastern Alaska were, as in previous years, at the gold mines in the Juneau district. All the productive copper mining of southeastern Alaska was in the Ketchikan district. Placer mining was limited to the Porcupine district and to small beach operations at Lituya Bay and possibly at Yakataga.

In the Ketchikan district the It, Jumbo, Rush & Brown, Mamie, Salt Chuck, and Rich Hill copper mines were operated, each for at least part of the year, and produced about 1,372,347 pounds of copper and gold and silver valued at $37,952. All the mines of the Ketchikan district were affected by shortage of labor and ships. The Dunton gold mine at Hollis was operated on the customary scale.

In the Juneau district the Alaska Gastineau, Alaska Juneau, and Ready Bullion mines were operated throughout the year, but at a reduced capacity because of scarcity of labor, and the Peterson mine was operated during the summer as usual. Work preparatory to mining was undertaken at several nonproducing mines.

In the Sitka district the Chichagof mine was operated throughout the year and made an unusually large production. Extensive developments were under way at the Hirsch-Chichagof property.

COPPER RIVER REGION.

The productive mines of the Copper River region in 1918 included 5 copper mines and 1 lode gold mine in the Chitina Valley and about 22 placer-gold mines in the Nizina, Chistochina, and Nel-china districts. The total of the mineral output of the Copper River region included copper, silver, gold, and platinum and had a total value of $13,811,135.

In the Chitina Valley the Kennecott-Bonanza and Jumbo copper mines were in continuous operation, except when the Bonanza mine was shut down for two weeks because the tram had been carried away by snowslides. Shipments of copper ore were also made from the Mother Lode, Nugget Creek, and Westover mines.

The gold mine of the North Midas Copper Co., on Kuskulana River, was operated part of the year, and a carload of ore from this mine was shipped during the winter. A mill and cyanide plant were installed during the summer and were reported to be in operation in November.

The Nizina gold placers are still worked on a large scale. Gold valued at $135,000 was recovered by 7 mines operating in the summer and 4 mines operating in the winter. About 70 men were employed in the summer and 7 men in the winter. Some placer copper was recovered.

The Chistochina placer mines are said to have had a very successful season and to have produced gold valued at $100,000 from the summer operations of 14 mines employing 50 men.

PRINCE WILLIAM SOUND.

The value of the minerals produced on Prince William Sound was $3,990,914 in 1918, compared with $4,667,929 in 1917. This amount is the value of the product at 5 copper mines and 4 gold mines. By far the larger part of the copper output of Prince William Sound in 1918 came, as in previous years, from the Beatson-Bonanza mine, which, because of the increased capacity of the mechanical equipment, was operated throughout the year on a larger scale than ever before, although the supply of labor was short. The other copper mines in operation, including the Ellamar mine, which was operated throughout the year, but at a reduced capacity owing to the shortage of labor and shipping, and the Fidalgo or Schlosser mine, on Fidalgo Bay, which was operated throughout the year on about the same scale as in 1917. The Midas mine, near Valdez, and the Blackbird group, on Latouche Island, were operated during part of the year.

Gold mining on Prince William Sound was confined to the operation of 4 mines in the Valdez and Port Wells districts, which yielded only a small production. Some ore was mined and milled at the Gold King, Cliff, and Alaska Homestake mines, and at the Big Four property, on Mineral Creek.

KENAI PENINSULA.

The production from the gold mines of Kenai Peninsula in 1918 amounted to about $14,000 in gold, and a small amount in silver obtained incidentally to the mining of the gold. There was very little activity in lode-gold mining and no extensive developments are reported. Four small gold mines produced gold valued at $6,016 and silver valued at $181 from 207 tons of ore. Placer mining continued on a small scale at various localities and gold estimated at $8,000 was produced.

SUSITNA REGION.

WILLOW CREEK DISTRICT.

The lode-gold mines of the Willow Creek district report a very successful season. The Gold Bullion, Gold Cord, Alaska Free Gold, Mabel, and Talkeetna mines were operated and produced gold valued at $269,624 and silver valued at $724 from 7,976 tons of ore. Development work was carried on and a small mill was erected at the War Baby mine on Craigie Creek.

YENTNA DISTRICT.

The Cache Creek placers in the Yentna district are estimated to have produced in 1918 gold valued at $150,000 from the operation of 16 mines and 1 dredge. About 120 men were employed in productive mining, and there were also a few parties doing dead work. Mining was somewhat curtailed by shortage of water, but on the whole a favorable season was reported. The dredge on Cache Creek operated successfully in 1918, but it is reported that the dredge will not operate during part of the season of 1919 while electric power is being installed on it.

UPPER SUSITNA REGION.

A little placer gold was mined in the Valdez Creek district in 1918. Interest in the gold, copper, and antimony lodes of the Kashwitna, Iron Creek, Upper Chulitna, and Broad Pass districts still continues, but active work on them has for the most part been suspended pending the extension of the railroad and in the hope of cheaper and more abundant labor and supplies.

SOUTHWESTERN ALASKA.

There was very little mining activity in southwestern Alaska in 1918. A little placer gold was recovered from the beaches of Kodiak Island, from a creek near Katmai, and from Portage Creek, a tributary to Clark Lake. Development work was continued in a small way at the McNeil property or Reward-Ridgway group, near Kamishak Bay, and a test shipment of copper ore was made. Work was continued at the copper prospect of the Shelikof Mining Co., near Kukak Bay on the Alaska Peninsula, but no ore has been shipped.

YUKON BASIN.

GENERAL STATEMENT.

The value of the gold produced by the placer mines of the Alaska Yukon districts in 1918 is estimated to have been $4,264,000, compared with $6,583,000 in 1917. The production in 1918 is the smallest recorded since 1904. The decrease was general throughout the region, except in some of the upper Yukon districts, and was due to the high cost of operating, the scarcity of labor, and a general hesitation to undertake ventures in the face of future uncertainties. Three hundred and fifty-five placer mines were operated in the summer of 1918, giving employment to 1,965 men, and 121 placer mines were operated in the winter of 1917–18, employing 490 men. The following table gives the estimated output of gold in the principal Yukon placer camps in 1918:

Estimated value of gold produced from placers of Yukon basin, 1918

Iditarod	$1,240,000	Marshall	$150,000
Tolovana	875,000	Koyukuk	150,000
Fairbanks	800,000	Innoko and Tolstoi	120,000
Ruby	400,000	All others	204,000
Circle	175,000		
Hot Springs	150,000		4,264,000

The placer mines of the Yukon region in Alaska are estimated to have produced silver to the value of $28,831 in 1918. The lode mines produced $26,750 in gold, $616 in silver, and a small quantity of lead.

FAIRBANKS DISTRICT.

The mineral production of the Fairbanks district in 1918 included placer gold worth $800,000, lode gold worth $26,750, placer silver worth $5,708, lode silver worth $616, and lead, tungsten, and antimony worth $15,915. The total value of the mineral output for 1918 was $848,989.

The production of the placer mines was $510,000 less than in 1917. A large number of operators did not undertake any work and others shut down during the summer. It is estimated that 68 mines, employing 390 men, were operated for at least part of the summer of 1918 and 35 mines employing 170 men in the winter of 1917–18. The old dredge of the Fairbanks Gold Mining Co. on claim "No. 6 above," Fairbanks Creek, was operated throughout the season. A Bucyrus dredge, with a capacity of 3,000 yards per day, equipped with 4-foot buckets, a Neil jig, and two 120-horsepower Diesel engines, which was installed by the same company on "No. 1 below," Fairbanks Creek, was completed and was expected to begin operations late in the summer. Some interest was aroused by the discovery of pay in shallow bench gravels on Ophir Creek, tributary to Beaver.

Lode mining in the Fairbanks district included the operation of 6 small gold mines, whose combined output of gold and silver, including that of three additional prospects or mines that were not in regular operation, was valued at $27,366, compared with $49,607 in 1917. A little lead was also produced in 1918. The productive gold-lode mines included the Mizpah, Crites & Feldman, and Rob-Roy mines, on Fairbanks Creek; the David mine, on Skoogy Gulch; the Creighton & Heilig mine, on Little Eldorado Dome; and the Smith & McGlone and Tyndall & Finn mines, on Eva Creek. At the St. Paul mine some ore was mined but not milled. At the Ohio claim of John Rogach, situated at the head of Spruce Creek, a little ore was mined and milled, but the work was more in the nature of prospecting than of regular mining. Some silver-lead ore from the Fairbanks district was treated in 1918 at the experiment station of the Bureau of Mines in Fairbanks and at the Tacoma smelter.

HOT SPRINGS DISTRICT.

The placer mines of the Hot Springs district are estimated to have produced $150,000 in gold in 1918, compared with $450,000 in 1917. There was a general suspension of gold mining because of shortage of labor and high cost of mining. Construction of a large ditch has been begun by Howell & Cleveland preparatory to hydraulic mining on the benches of Sullivan Creek. The gravels on lower Patterson Creek are said to have been extensively prospected by drilling with encouraging results.

TOLOVANA DISTRICT.

The production of gold from the placers of the Tolovana district is estimated at $875,000 in 1918, compared with $1,150,000 in 1917. This falling off in production was due largely to the working out of a number of claims, but also to the exceptionally dry summer and the scarcity of labor. Unless a strike is made in the district a further decrease may be expected in 1919. Practically the total output of the district comes from Tolovana and vicinity, and the principal producing creeks are Tolovana, Amy, Lillian, Olive, Lucky, Ruth, and Gertrude. Thirty-five mines were operated in 1918, against 50 in 1917, and 270 men were engaged in mining. Three or four of the plants employed more than 25 men each. Eight of the mines were worked out during the season or were found to be of too low grade to be worked next year. Three mines cleaned up the preceding winter's dumps and then ceased to do further work. Twenty-nine mines are expected to be in operation next year. Twenty-two mines had underground workings.

RAMPART DISTRICT.

The production of placer gold in the Rampart district in 1918 was about $24,000, derived from the operation of 9 mines employing 24 men in the summer of 1918 and 2 mines employing 4 men in the winter of 1917–18. The most extensive operations were on Hunter Creek, where two hydraulicking plants have been installed. With the rest of Alaska the Rampart district suffered from the scarcity of labor.

SALCHAKET-TENDERFOOT DISTRICT.

The Tenderfoot district, which in past years yielded a considerable quantity of gold, has practically ceased to produce. The output for 1918 probably did not exceed $6,000. Discoveries of gold were reported in 1918 as in previous years at various localities in the Salchaket and Goodpasture districts, but none of them has proved of importance.

CHISANA DISTRICT.

Very little authentic information concerning mining in the Chisana district in 1918 has been received. It is believed that mining was curtailed as in most Alaskan districts and that the output of gold did not exceed $15,000.

KANTISHNA DISTRICT.

The mineral production of the Kantishna district in 1918 consisted of placer gold worth about $30,000. Twenty-five or thirty men were engaged in mining. Preparations were made for mining silver-lead ore and antimony ore.

BONNIFIELD DISTRICT.

The placer mines of the Bonnifield district produced $8,000 in gold in 1918. Five mines employing 12 men were operated on Moose, Daniels, and Healy creeks. Some work was done at the lode prospects on the divide between Moose and Eva creeks. No information has been received concerning the placers in the eastern part of the Bonnifield region. One man was engaged in placer mining in a small way on Rainy Creek, a tributary to Delta River.

CIRCLE DISTRICT.

Mining in the Circle district in 1918 was confined as usual to the gold placers, which produced $175,000 in gold. Thirty-five mines, employing 93 men, were operated in the summer of 1918 and 15 mines, employing 28 men, in the winter of 1917–18. The dredge on Mastodon Creek was operated as usual. The supply of water was reported to be ample throughout the district. No new discoveries were made and no important new projects were undertaken.

FORTYMILE DISTRICT.

The output of gold in the Fortymile district in 1918 was $75,000 and was derived from the operation of 60 mines employing 93 men in the summer of 1918 and 29 mines employing 48 men in the winter of 1917–18. There was no dredging in 1918; it was reported that the dredge which had previously been operated was found not to be suitable for the ground. The high benches near the mouth of Dennison Fork were prospected extensively, and it is said that plans are under consideration for the construction in 1919 of a ditch 21 miles long on the bank of Dennison Fork.

EAGLE DISTRICT.

The production of placer gold in the Eagle district in 1918 was $25,000, or nearly double that of 1917. The increase was due to the operation of two new hydraulic plants. Fourteen mines employing 40 men were operated in the summer of 1918 and 1 mine employing 2 men in the winter of 1917–18.

CHANDALAR DISTRICT.

Little information has been received concerning mining in the Chandalar district. The placers were apparently worked on the customary scale; 4 summer mines and 3 winter mines employing 10 and 6 men, respectively, produced $13,000 in gold.

KOYUKUK DISTRICT.

The gold placers of the Koyukuk district are believed to have produced about $150,000 in gold in 1918. Twenty mines employing 150 men are reported as having operated in the summer of 1918 and 3 mines employing 10 men in the winter of 1917–18.

INDIAN RIVER AND GOLD HILL DISTRICTS.

The production of gold in the Indian River and Gold Hill placers in 1918 was probably not more than $4,000. Only 2 mines, employing 8 men, are known to have operated in the Indian River district, and 1 mine in the Gold Hill district.

IDITAROD DISTRICT.

The placer mines of the Iditarod district are believed to have yielded about $1,240,000 in gold in 1918, compared with $1,500,000 in 1917. Three dredges produced $750,000 in gold. It is reported that a claim on a hill at the head of Flat Creek yielded $84,000.

RUBY DISTRICT.

The production of gold in the Ruby district in 1918 was $400,000—less than half the output in 1917. The decrease was due largely to the idleness of the Greenstone dredge, its ground having been worked out in 1917. Some of the smaller operators suspended work on account of high prices of supplies and material.

INNOKO AND TOLSTOI DISTRICTS.

The production of placer gold in the Innoko and Tolstoi districts was probably $120,000 in 1918. The output in the Tolstoi district decreased considerably, only 1 mine being reported as productive in 1918, but it is said that encouraging new discoveries have been made.

MARSHALL DISTRICT.

The output of placer gold in the Marshall district in 1918 was estimated at $150,000. Since mining began, in 1914, the Marshall placers have yielded gold valued at $885,000.

STUYAHOK RIVER.

Some interest was aroused on the lower Yukon in the fall of 1918 by the report that valuable gold placers had been located on Stuyahok River, 6 miles north of Tucker's Fish Camp. The Stuyahok is tributary from the south to Bonasila River, which enters the Yukon about 10 miles below Anvik. It had previously been known[1] that there was gold on the Stuyahok, but no mining had been done. No detailed information has been received concerning the discovery and the excitement is said to be subsiding.

KUSKOKWIM REGION.

The production of gold in the Kuskokwim region in 1918, according to such scanty information as is available, was about $100,000. The greater part of the output came from the Mount McKinley precinct, where a dredge began working, though not satisfactorily, on Candle Creek. In the Goodnews Bay or Quinhagak district, 6 mines were operated, which employed 30 men and produced gold valued at $30,000. The discoveries reported from the Goodnews Bay district in 1917 have not yet proved to be of great importance. Placer mining still continues in a small way in the Georgetown and Tuluksak-Aniak districts.

NORTON SOUND.

A little placer gold was produced in 1918, as in previous years, from Bonanza Creek in the St. Michael district, where the operation of 2 small mines was reported.

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[1] Harrington, G. L., The Anvik-Andreafski region, Alaska: U. S. Geol. Survey Bull. 683, p. 56, 1918.

SEWARD PENINSULA.

The value of the mineral production of Seward Peninsula in 1918 was $1,195,172, compared with $2,747,000 in 1917. Of the output in 1918, $1,108,000 represents the value of the placer gold and $87,172 the value of the miscellaneous products, including tin, tungsten, silver, and platinum.

The production of placer gold was less than half that of 1917 and was the smallest since 1898. The decrease was due to labor difficulties, to the high cost of operating, and to unfavorable climatic conditions, including deep frost, scanty water, and a short season. The production of placer gold by districts was as follows:

Nome	$447,000	Koyuk	$135,000
Solomon	49,000	Kougarok	50,000
Council	307,000	Port Clarence	7,000
Fairhaven	113,000		

Twenty-one gold dredges operated during the season of 1918, seven less than in 1917. The dredges employed 152 men and produced gold valued at $466,000, or 42.1 per cent of the total production of Seward Peninsula. Of the dredges, 6 were in the Nome district, 7 in the Council district, 5 in the Solomon district, 2 in the Fairhaven district, and 1 in the Kougarok district.

Twenty-eight underground mines, employing 177 men, operated in 1918, and produced gold worth about $279,000, or 25.2 per cent on the total production of the peninsula. Of the underground mines 21 were in the Nome district, 4 in the Fairhaven district, and 3 in the Koyuk district.

Twenty-four hydraulic mines employed 170 men and produced gold worth $259,500, or 23.4 per cent of the total production. Of the hydraulic mines 10 were in the Nome district, 1 in the Solomon district, 4 in the Council district, 5 in the Fairhaven district, 3 in the Koyuk district, and 1 in the Kougarok district.

Fifty-five open-cut mines, other than hydraulic, employed 134 men and produced gold worth $103,500, or 9.3 per cent of the total production. Of the open-cut mines 13 were in the Nome district, 6 in the Council district, 11 in the Fairhaven district, 15 in the Kougarok district, 4 in the Koyuk district, and 6 in the Port Clarence district.

The only new strike of the season was made on Poorman bench, Monument Creek, in the Nome district, where gravels carrying $32 to the cubic yard were discovered.

Little work was done on the lodes of Seward Peninsula in 1918, and no ore was shipped. Considerable work preparatory to mining was done on the Lost River tin lodes and on a silver-lead lode on Kougarok River, where some ore was mined.

KOBUK RIVER.

The production of gold on Kobuk River for 1918 was estimated at $15,000. Thirty-five men were engaged in mining operations. It is reported that favorable prospects were discovered on California Creek, a tributary of the Kugaluktuk.

QUICKSILVER.

By F. L. Ransome.

STATISTICAL SUMMARY.

Quicksilver produced in the United States in 1918.

State.	Ore treated (short tons).	Percentage tenor won.	Quantity (flasks of 75 pounds).	Value.
California	[a]355,000	0.24	22,664	$2,663,020
Texas	36,482	.87	8,451	992,992
Nevada	11,078	.35	1,044	122,670
Oregon	13,034	.20	702	82,485
Idaho	60	1.37	22	2,585
	415,654	.30	32,883	3,863,752

[a] Does not include an unknown quantity of old dump material from which 74 flasks of quicksilver were obtained by concentrating and retorting.

Average price per flask:	
San Francisco	$117.50
New York	123.47
London	Quoted only as "nominal."
Total number of mines producing	47
Total decrease of production in 1918 from 1917 ... flasks	3,276
Total exports from United States (3,098 flasks) ... pounds	232,346
Total imports into United States (6,719 flasks) ... do	503,907

INTRODUCTION.

There were no events of conspicuous importance or unusual interest in the quicksilver industry in 1918. The number of producing mines was slightly smaller than in 1917 and, although the average price of quicksilver was higher than in any year on record except 1916, the output of the mines showed a decided decrease. Probably no single cause was altogether responsible for this falling off. The high cost of labor and supplies, the influenza epidemic, the withdrawal of trained and efficient men by the operation of the draft law, were all undoubtedly contributory to the result. A more important cause, however, than any single one mentioned was the complete or partial exhaustion of those bodies of ore that were readily accessible and could be quickly mined when the war demand and consequent high prices first stimulated the quicksilver mines to unusual efforts. This is clearly shown not only by the decrease in production but by the marked diminution in the tenor of the ore worked. Few operators ceased production in 1918, but many of them were unable to find sufficient ore of a grade that would enable them to gain a profit even at the prevailing good prices.

At the end of the year the trend of prices was downward and there was much uncertainty as to the future of the domestic quicksilver-mining industry. At the date of writing (July 1, 1919), however, the outlook is rather more encouraging to the producers.

PRODUCTION.

WORLD'S PRODUCTION.

In the following table are given the best figures available for the world's production of quicksilver in recent years. The foreign figures, generally published in metric tons, are calculated to flasks of 75 pounds net by multiplying by the factor 29.395. As far as possible the figures are taken from official statistical publications of the respective countries. Where no trustworthy data are obtainable the output is estimated on such miscellaneous information as could be collected. This expedient unfortunately has been necessary in the case of Austria and Hungary, for which no statistics have been obtainable since the outbreak of the war. The estimate of production for "Mexico and other countries" is admittedly based upon very meager data.

World's production of quicksilver, 1909–1917, in flasks of 75 pounds.

[1 metric ton=29.395 flasks.]

Country.	1909	1910	1911	1912	1913	1914	1915	1916	1917
United States	21,075	20,601	21,256	25,064	20,213	16,548	21,033	29,932	36,159
Austria	[a] 17,196	[a] 17,725	[a] 20,694	[a] 22,428	[a] 24,104	[b] 25,000	[b] 25,000	[b] 25,000	[b] 25,000
Hungary	[c] 2,098	[c] 2,641	[c] 2,339	[c] 2.494	[c] 2,606	[b] 2,500	[b] 2,500	[b] 2,500	[b] 2,500
Italy	[d] 22,668	[d] 26,264	[d] 28,072	[d] 29,406	[d] 29,513	[d] 31,541	[d] 28,954	[e] 32,129	[f] 29,300
Russia	[g] 206	[h] 118	....	....	....	....	[h] 800	[h] 1,100	[b] 500
Spain	[i] 40,933	[i] 32,892	[i] 43,912	[i] 36,921	[i] 36,619	[i] 28,000	[i] 35,925	[i] 23,369	[i] 25,147
Mexico and other countries	[b] 4,500	[b] 4,500	[b] 4,500	[b] 4,500	[b] 4,000	[b] 4,000	[b] 4,000	[b] 4,000	[b] 4,000
	108,676	104,741	120,773	120,813	117,055	107,589	118,212	118,030	122,606

[a] Statistik des Bergbaues in Osterreich, Wien.
[b] Statistics not available. Estimate only.
[c] Ungar. statist. Jahrb., Budapest.
[d] Riv. servizio min., Roma.
[e] Min. Jour., London.
[f] Eng. and Min. Jour., Feb. 16, 1918 ("nearly 1,000 tonnes").
[g] Statistics of the mineral industry of Russia, Petrograd.
[h] Metallgesellschaft, Frankfurt-am-Main.
[i] Statistics not available. Estimate based on oral information from Russian Special Commission to United States in 1917.
[j] Estadística minera de España, Madrid.

The ultimate control of the Idria deposits remains in doubt at the date of writing. At the end of 1918 the mine was being worked by the Austrian technical staff under the supervision of Italian engineers and the entire output was being requisitioned by the Italian ministry of war. Regents decree No. 1721 (Italy), dated November 18, 1918, states that

> Dating from a day which shall be appointed by royal decree on the proposal of the ministry of finance of the treasury, and of others concerned, the State shall assume, with the right to monopolize, the stocking and the sale, jointly or separately, of the following products:
>
> [Here follows a list.]
>
> On the same date the State will assume the monopoly of the extraction of mercury in the territory of the Kingdom and its sale inland and abroad. * * *

The decree had not been put into effect at the end of 1918.

Early in 1919 the Spanish Government by agreement with the Rothschilds of London increased the quantity of quicksilver formerly retained by Spain from the Almaden mine (500 flasks annually) to 1,000 flasks.

DOMESTIC PRODUCTION.

Including some small prospects that yielded only a flask or two from development work, there were 47 productive quicksilver mines in the United States in 1918, against 51 in 1917 and 66 in 1916. This number includes three sources of metal entirely from old dumps and at least two important mines at which dumps and ground under old reduction works contributed a large part of the total output. Of the productive mines, 34 were in California, 5 in Nevada, 4 in Texas, 2 in Oregon, and 2 in Idaho.

According to confidential returns to the Geological Survey from individual mine operators, the output of quicksilver in the United States in 1918 was 32,883 flasks of 75 pounds each, against 36,159 flasks in 1917 and 29,932 flasks in 1916.

At the average price for the year, $117.50 a flask, based on quotations for domestic quicksilver in San Francisco, published weekly in the Mining and Scientific Press, the value of the output in 1918 was $3,863,752, an increase of $55,486 over 1917, and a sum exceeded only in the year 1875, when the value of the output was $4,228,538. The producers of 15,333 out of the total 32,883 flasks stated on their statistical returns the prices received for their product. These averaged $118.81 a flask, or $1.31 more than the average quotation in San Francisco.

Quicksilver produced in the United States, 1913–1918, in flasks of 75 pounds.

State.	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Arizona Oregon[a] Texas	2,977	$119,765	3,156	$154,801	4,423	$379,493
California	15,591	627,228	11,303	554,414	14,283	1,225,481
Nevada	1,645	66,178	2,089	102,465	2,327	199,657
	20,213	813,171	16,548	811,680	21,033	1,804,631

State.	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Arizona	5	$629	40	$4,213	....	....
Oregon	[b] 378	47,587	388	40,864	702	$82,485
Texas	6,306	793,862	10,791	1,136,508	8,451	992,992
California	21,045	2,649,355	23,938	2,521,151	22,664	2,663,020
Nevada	2,198	276,706	997	105,004	1,044	122,670
Idaho	....	....	5	526	22	2,585
	29,932	3,768,139	36,159	3,808,266	32,883	3,863,752

[a] Oregon had no output in 1913 and 1914.

[b] Includes 75 flasks from Washington.

The following table gives the quantity, average price, and value of the quicksilver produced annually in the United States from the year 1850. Up to 1882 this table is identical with that on page 159, which shows the production of California:

Quicksilver produced in the United States, 1850–1918.

[In flasks of 76.5 pounds to June, 1904; subsequently in flasks of 75 pounds.]

Year.	Flasks.	Price per flask.	Value.	Year.	Flasks.	Price per flask.	Value.
1850	7,723	$99.45	$768,052	1886	29,981	$35.50	$1,064,325
1851	27,779	66.93	1,859,248	1887	33,825	42.375	1,433,334
1852	20,000	58.33	1,166,600	1888	33,250	42.50	1,370,625
1853	22,284	55.45	1,235,648	1889	26,484	45.00	1,191,780
1854	30,004	55.45	1,663,722	1890	22,926	52.50	1,203,615
1855	33,000	53.55	1,767,150	1891	22,904	45.25	1,036,406
1856	30,000	51.65	1,549,500	1892	27,993	40.71	1,139,595
1857	28,204	48.73	1,374,381	1893	30,164	36.75	1,108,527
1858	31,000	47.83	1,482,730	1894	30,416	30.70	933,771
1859	13,000	63.13	820,690	1895	36,067	37.04	1,335,922
1860	10,000	53.55	535,500	1896	30,765	34.96	1,075,544
1861	35,000	42.05	1,471,750	1897	26,691	37.28	995,040
1862	42,000	36.35	1,526,700	1898	31,092	38.23	1,188,647
1863	40,531	42.08	1,705,544	1899	30,454	47.70	1,452,656
1864	47,489	45.90	2,179,745	1900	28,317	44.94	1,272,566
1865	53,000	45.90	2,432,700	1901	29,727	48.46	1,440,570
1866	46,550	53.13	2,473,202	1902	34,291	43.20	1,481,371
1867	47,000	45.90	2,157,300	1903	35,634	45.29	1,613,864
1868	47,728	45.90	2,190,715	1904	35,315	43.50	1,536,203
1869	33,811	45.90	1,551,925	1905	30,534	36.22	1,105,941
1870	30,077	57.38	1,725,818	1906	26,083	39.50	1,030,279
1871	31,686	63.10	1,999,387	1907	21,554	39.60	853,538
1872	31,621	65.93	2,084,773	1908	19,752	44.17	872,446
1873	27,642	80.33	2,220,482	1909	21,075	45.45	957,859
1874	27,756	105.18	2,919,376	1910	20,601	46.51	958,153
1875	50,250	84.15	4,228,538	1911	21,256	46.01	977,989
1876	72,716	44.00	3,199,504	1912	25,064	42.05	1,053,941
1877	79,395	37.30	2,961,434	1913	20,213	40.23	813,171
1878	63,880	32.90	2,101,652	1914	16,548	49.05	811,680
1879	73,684	29.85	2,199,467	1915	21,033	85.80	1,804,631
1880	59,926	31.00	1,857,706	1916	29,932	125.89	3,768,139
1881	60,851	29.83	1,815,185	1917	36,159	105.32	3,808,266
1882	52,732	28.23	1,488,624	1918	32,883	117.50	3,863,752
1883	46,725	28.75	1,343,344				
1884	31,913	30.50	973,347		2,338,013	....	112,571,830
1885	32,073	30.75	986,245				

The quantity and value of the quicksilver produced annually in the United States are also shown graphically in figure 3.

QUANTITY AND TENOR OF ORE MINED AND TREATED.

According to reports from producers, supplemented by estimates for a few mines whose operators gave no figures for ore raised, there was mined in 1918 about 422,000 short tons of ore. This includes 87,500 tons of low-grade dump material excavated with a steam shovel at Sulphur Bank, 13,191 tons of earth from under old reduction works at Almaden, and an unknown quantity of dump material which was treated at New Idria with newly mined ore. It does not include, however, a relatively small quantity of dump material handled by a few small operators who produced therefrom a total of 74 flasks, but kept no record of the quantity of material worked over. There was treated in furnaces 305,972 short tons of ore (including some concentrates), which yielded 29,418 flasks of quicksilver. This is at the rate of 0.37 per cent, or 7.4 pounds of quicksilver to the ton of ore, whereas in 1917 the average yield of furnace ore was 0.46 per cent, or 9.2 pounds to the ton. There was treated in retorts, with at one or two mines some preliminary concentration, about 8,991 short tons of ore, which yielded 1,951 flasks of quicksilver. This is at the rate of 0.81 per cent, or 16.2 pounds of quicksilver to the ton of ore, as compared with 1.22 per cent, or 24.4 pounds in 1917. In addition the concentrates from the Sulphur Bank dumps, Calif., estimated roughly at 2,200 tons, were also retorted. At New Almaden, Calif., 13,191 tons of earth from the sites of old furnaces and condensers yielded 400 flasks of quicksilver by washing, without further metallurgical treatment. The total quantity of material treated by all methods was 415,654 tons.

Although the ores mined and treated by the usual methods were undoubtedly as a rule of lower grade than those worked in 1917, the striking differences shown in the above table, particularly as regards California and the totals and average for the United States, are partly due to the large quantity of low-grade material handled with a steam shovel at Sulphur Bank and concentrated before being

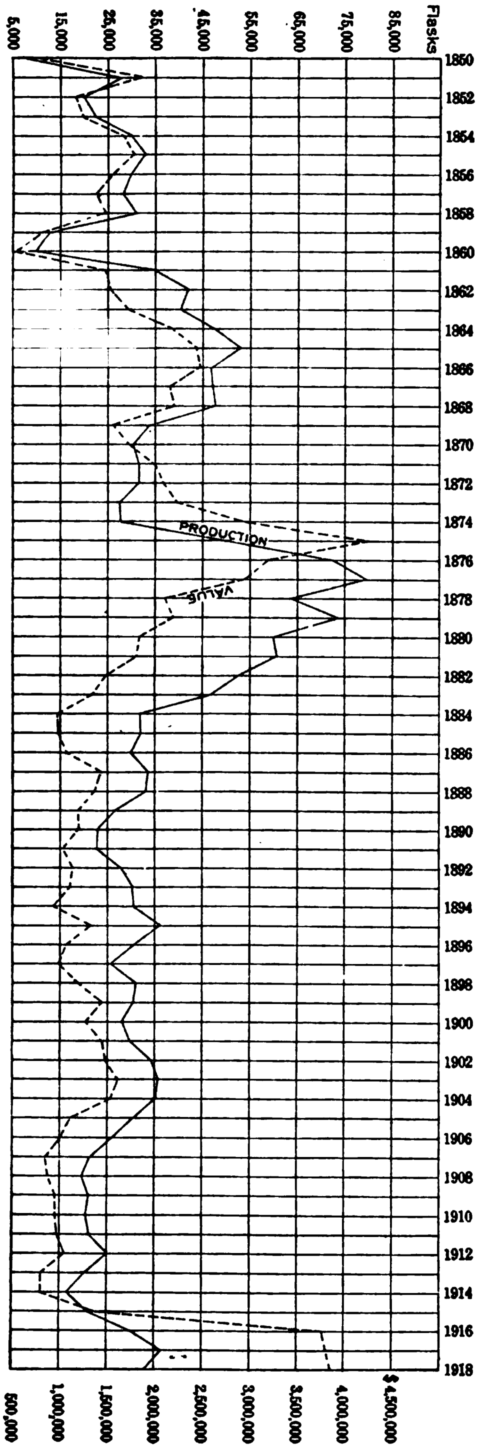

FIGURE 3.—Diagram showing quantity and value of quicksilver produced in the United States from 1850 to 1918, inclusive.

retorted. Much of this material was rejected by passage over grizzlies before reaching the concentrating mill.

Quicksilver ore treated and metal won in the United States, 1915–1918.

State.	1915			1916			1917			1918		
	Ore treated (short tons).	Metal won (pounds per ton).	Percentage tenor won.	Ore treated (short tons).	Metal won (pounds per ton).	Percentage tenor won.	Ore treated (short tons).	Metal won (pounds per ton).	Percentage tenor won.	Ore treated (short tons).	Metal won (pounds per ton.	Percentage tenor won.
Arizona	7,321	45.3	2.27	2	......	......	79	38.0	1.90	......	......	......
Oregon				[a] 5,802	4.8	0.24	12,732	[b] 2.3	[b] .11	13,034	4.0	0.20
Texas				25,945	18.2	.91	28,242	28.4	1.42	36,482	17.4	.87
California	129,521	8.3	.41	205,072	7.6	.38	235,786	7.6	.38	355,000	4.8	.24
Nevada	21,975	7.9	.40	12,911	12.6	.63	3,639	20.4	1.02	11,078	7.0	.35
Idaho	......	......	......	......	......	......	6	62.4	3.12	60	27.4	1.37
	158,817	9.9	.50	249,732	9.0	.45	280,484	9.6	.48	415,654	6.0	.30

[a] Includes 47 tons from Washington.
[b] These figures abnormally low, owing to accumulation of unworked soot.

The table below shows the relative importance of furnaces and retorts in the production of domestic quicksilver. The furnaces are preponderantly fine-ore inclined-tile furnaces of the Hüttner-Scott type, but include some coarse-ore shaft furnaces of simple construction and a few exception models. The retorts are chiefly of the cylindrical pipe form, usually arranged in "banks" or "benches" of 12 retorts, but include also a number of the D pattern and a few unusual varieties.

Quicksilver ore treated in furnaces and in retorts in 1918.

State.	Ore treated (short tons).[a]		Quicksilver won (flasks).		Percentage tenor won.	
	Furnaces.	Retorts.	Furnaces.	Retorts.	Furnaces.	Retorts.
California [b]	249,399	4,910	20,279	871	0.30	0.66
Texas	34,142	2,340	7,899	552	.87	.88
Other States [c]	22,431	1,741	1,240	528	.21	1.13
	305,972	8,991	29,418	1,951	.37	.81

[a] In small part made up of estimates, as some producers do not accurately record the quantity of ore treated.
[b] This table does not include 87,500 tons of dump material, handled by a steam shovel. Concentrates from this material, estimated at about 2,200 tons, were retorted and yielded 1,040 flasks. Neither does it include 13,191 tons of material from under old reduction works, which yielded 400 flasks by washing, nor dump material at various localities, from which was obtained 74 flasks of quicksilver by concentration and retorting. It does, however, include considerable dump material which at one large mine was not accounted for separately from newly mined ore.
[c] Includes Idaho, Nevada, and Oregon.

This table, like the preceding one, shows a notable decrease in the tenor of the ore worked in 1918, as compared with 1917. In 1917 the average tenor won by furnaces in the United States was 0.46 per cent and by retorts, 1.34 per cent if the Sulphur Bank, Calif., concentrates are included or 1.22 per cent if the comparison is restricted to retorted ores.

METHODS OF PRODUCTION.

The volume on "The quicksilver resources of California," by W. W. Bradley, published in 1918 as Bulletin 78 of the California State Mining Bureau, treats extensively of the metallurgy of quicksilver ores and should be consulted by those interested in this subject. The results of the investigations of the United States Bureau of Mines, referred to in the report for 1917, have also appeared in part as Technical Paper 96, "Fume and other losses in condensing quicksilver from furnace gases," by L. H. Duschak and C. N. Shuette, published in 1919.

The ores of quicksilver, unlike those of most metals that are won by smelting, are without exception in this country treated at the mines, and the liquid metal is shipped as a finished commercial product. A moderate heat, about 360° C., is sufficient to vaporize and decompose cinnabar, and metallic quicksilver is readily obtained by condensation. In outline the process is exceedingly simple, but in practice it is by no means easy so to control the operation as to obtain practically all of the metal from the ore with the minimum expenditure of labor and fuel.

In general, two classes of reducing plants may be distinguished, namely, furnaces and retorts. In the furnaces, with the exception of the Fitzgerald furnace and the Livingston retort furnace, which are little used, the ore is exposed to the direct action of the flame and the volatile products of combustion, with more or less dust, as well as the mercury vapor, are drawn into the condensing chambers. In retorts, on the other hand, the ore is heated in a closed vessel, out of contact with the flame, and only those volatile constituents that are driven off from the charge pass into the condensers. Furnaces are comparatively expensive, but have greater capacity than retorts, cost much less to operate per ton of ore, and, for ores of medium and low grade, are more efficient. Retorts, on the other hand, are comparatively cheap and can be successfully employed in treating small bodies of rich ore, although their use is attended with the ever-present danger of salivation or mercurial poisoning. The relative importance of the two classes of reduction plants may be seen from the table on page 148.

The standard furnace in the United States is the Hüttner-Scott, or, as it is commonly called, the Scott furnace. This is a masonry structure of rectangular shaft form and requires special skill in its construction. The ore is fed at the top and falls over a series of alternating or "staggered" fire-brick shelves inclined at 45°. The rate of passage through the furnace is controlled by drawing off portions of the spent charges at regular intervals from the bottom of the shaft, and the burning is continuous. The flames pass back and forth through the flues formed by the spaces that the ore does not fill under the sloping shelves. The shelves are arranged in one to five vertical compartments, according to the size of the furnace. The fuel is wood or oil and is burned in one or more fire boxes, not mixed with the ore.

Rotary furnaces, such as were described in the report on the production of quicksilver in 1917, were in successful operation at New

Idria, Calif., but at Sulphur Bank, in the same State, considerable difficulty was experienced with a furnace of this type in consequence of the large quantity of free sulphur in the ore. Much of this sulphur was sublimed and redeposited instead of being burned to sulphur dioxide. Rotary furnaces were also installed at two other mines in California, but apparently were not in full operation at the end of the year.

Concentration of the ordinary wet gravity method was in use at New Idria as an adjunct to the furnaces and at Sulphur Bank. Flotation was practiced at Black Butte, Oreg.

PRICES.

The average domestic price of quicksilver, although lower than in 1916, continued high in comparison with prewar prices. The average price quoted in New York was $123.47 per flask, as against $106.30 in 1917, and in San Francisco it was $117.50, as against $105.32 in 1917. The ore worked in 1918 was generally of lower grade than in 1917 and costs were considerably higher, so that the gain in price was not accompanied by an equal increase in profit to the producer.

The price of $105 a flask fixed in April, 1917, for Government purchases at the Mare Island Navy Yard, Calif., or of $105.75 in New York, continued effective until late in October, 1918, when all price control by the Government ceased.

The prices given in the following table for the United States and the United Kingdom have been obtained by averaging the weekly quotations published in the Mining Journal, for London; the Engineering and Mining Journal, for New York; and the Mining and Scientific Press, for San Francisco, the primary domestic market. As the figures prior to 1913, however, are not complete in the Mining and Scientific Press, they have been taken, for the years 1907–12, inclusive, from the Engineering and Mining Journal. Obviously, the figures given in this table, being annual averages, may differ considerably from the price actually quoted or obtained on a particular date.

Average yearly prices of quicksilver in the United States and the United Kingdom from 1907 to 1918, inclusive.

[Per flask of 75 pounds.]

Year.	San Francisco[a] (domestic).	New York.[b]	London.[c]			Year.	San Francisco[a] (domestic).	New York.[b]	London.[c]		
			£	s.	d.				£	s.	d.
1907	$39.60	$41.50	7	0	6	1913	$40.23	$39.54	7	9	2
1908	44.17	44.84	8	4	8	1914	49.05	48.31	[d] 7	15	0
1909	45.45	46.30	8	12	0	1915	85.80	87.01	14	10	8
1910	46.51	47.06	8	16	0	1916	125.89	125.49	17	2	10
1911	46.01	46.54	8	4	11	1917	105.32	106.30	22	4	3
1912	42.05	42.46	8	2	10	1918	117.50	123.47	([e])		

[a] Min. and Sci. Press, San Francisco.
[b] Eng. and Min. Jour., New York.
[c] Min. Jour. (London).
[d] Metal exchange closed about three months after outbreak of war. Average based on 37 weeks only.
[e] Quoted as "nominal" only.

Although San Francisco is commonly referred to as the "primary market" for quicksilver in the United States, from the fact that the greater part of this metal produced in the country comes from the Pacific coast and goes through the hands of San Francisco firms, yet it should be noted that that city is not a market in the same sense as New York. Most of the quicksilver that passes nominally through San Francisco is handled on commission and is sold in New York, which consequently is the great distributing point of quicksilver to the actual consumers.

Prices of domestic quicksilver at San Francisco, 1916–1918.

[Per flask of 75 pounds.]

Month.	1916	1917	1918	Month.	1916	1917	1918
January	$222.00	$81.00	$128.06	July	$81.20	$102.00	$120.00
February	295.00	126.25	118.00	August	74.50	115.00	120.00
March	219.00	113.75	112.00	September	75.00	112.00	120.00
April	141.60	114.50	115.00	October	78.20	102.00	120.00
May	90.00	104.00	110.00	November	79.50	102.50	120.00
June	74.70	85.50	112.00	December	80.00	117.42	115.00

IMPORTS AND EXPORTS.

The import duty on quicksilver from 1890 to 1895 was 10 cents a pound. From 1895 to 1913 it was 7 cents. The Underwood tariff bill enacted in 1913 and still in force made the duty 10 per cent ad valorem, which at the average price in London for 1917, the latest year for which quotations are available, would be equivalent to an import tax of about 14 cents a pound.

In the following tables[1] are given imports of quicksilver for domestic consumption, total annual exports, and annual exports by countries. In 1918 the imports were greater by 113,413 pounds, or about 1,512 flasks, than in 1917, and the increase in the total value of the imports was $85,590. The exports decreased by 575,990 pounds, or about 7,680 flasks, with a decrease in value of $659,850. About 87.7 per cent of the total exports went to Canada, to be used chiefly in the manufacture of fulminate and glacial acetic acid for war purposes.

Quicksilver exported from the United States, 1909–1918.

Year.	Quantity.			Value.
	Pounds.	Metric tons.	Approximate equivalent in flasks of 75 pounds.	
1909	510,141	231.39	6,802	$266,243
1910	144,237	65.42	1,923	91,077
1911	21,841	9.91	291	13,995
1912	23,283	10.56	310	13,360
1913	85,521	38.79	1,140	43,574
1914	108,426	49.18	1,446	70,753
1915	252,852	114.69	3,372	225,509
1916	666,027	302.11	8,880	670,475
1917	808,336	366.66	10,778	998,470
1918	232,346	105.39	3,098	338,620

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[1] From the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Quicksilver imported and entered for consumption in the United States, 1909–1918.

Year.	Quantity.			Value.
	Pounds.	Metric tons.	Approximate equivalent in flasks of 75 pounds.	
1909	15,968	7.24	213	$8,203
1910	667	.30	9	381
1911	471,944	214.07	6,292	251,386
1912	82,706	37.52	1,103	39,920
1913	171,653	77.86	2,289	75,361
1914	614,869	278.90	8,198	271,984
1915	421,884	191.37	5,625	282,752
1916	424,396	192.50	5,659	515,919
1917	390,494	177.13	5,207	448,032
1918	503,907	228.57	6,719	533,622

Domestic quicksilver exported from the United States, 1917–18, by countries.

Destination.	1917		1918	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Europe:				
Azores and Madeira Islands	100	$124	....	....
Iceland and Faroe Islands	....	....	13	$32
England	92,314	101,825	19,550	32,500
France	9,543	11,040	....	....
Netherlands	375	400	....	....
Norway	9,365	14,993	....	....
Spain	126	148	....	....
North America:				
British Honduras	20	23	3	7
Canada	279,358	372,759	203,900	295,349
Mexico	815	1,059	28	46
Newfoundland	175	206	....	....
Central America:				
Costa Rica	292	362	....	....
Guatemala	270	329	10	21
Honduras	....	....	24	30
Nicaragua	1,152	1,628	265	360
Salvador	150	265	12	25
West Indies:				
British:				
Barbados	....	....	2	4
Jamaica	55	69	....	....
Trinidad and Tobago	....	....	213	212
Others	....	....	1	4
Cuba	1,127	1,287	463	782
Danish	....	....	60	100
Dominican Republic	90	99	10	18
Dutch	20	34	5	9
French	158	220	....	....
Haiti	....	....	26	53
South America:				
Argentina	1,515	2,397	22	34
Brazil	119	161	32	71
Chile	225	329	....	....
Colombia	329	406	96	170
Ecuador	675	936	10	19
Guiana:				
British	200	230	....	....
French	3,110	4,521	150	250
Peru	375	259	....	....
Venezuela	225	240	....	....
Asia:				
China	....	....	20	50
China, British leased territory	3,750	4,700	....	....
Chosen (Korea)	1,650	2,426	450	720
Hongkong	142,850	171,415	....	....
India (British)	....	....	10	20
Japan	178,625	196,952	....	....
Siberia	5	12	....	....
Straits Settlements	....	....	1.068	1,500
East Indies:				
British	90	100	....	....
Dutch	1,242	1,288	86	146
Oceania:				
Australia	33,365	43,077	805	804
New Zealand	9,525	10,033	75	125
Philippine Islands	455	518	637	953
Africa: British South Africa	34,500	51,600	4,300	4,206

USES OF QUICKSILVER.

The following are the principal uses of quicksilver under normal conditions, stated in general order of decreasing importance. Quicksilver enters largely into the manufacture of drugs and chemicals, including calomel and corrosive sublimate. Mercuric oxides and mercury salts are also used extensively in the manufacture of certain chemicals, such as glacial acetic acid, phthalic acid, and phthalic anhydride, into which mercury does not itself enter. Mercury fulminate, with the chemical formula $Hg(CNO)_2$, is used as a detonator for high explosives,[1] and to a less extent than formerly in small-arms ammunition. It is made by treating mercury with strong nitric acid and alcohol.

The discovery of mercury fulminate by Howard in 1799 led to the invention of the percussion cap in place of the old flintlock, and fulminate still remains the best-known and most-used detonator for gunpowder and high explosives. It is often combined with other substances, particularly with an abrasive, such as powdered glass, to increase its sensitiveness, and with compounds or mixtures that themselves have the property of detonating, such as sulphide of antimony and chlorate of potassium. Recently a large part of the mercury fulminate in detonators for modern high explosives has been replaced by picric acid, trinitrotoluene, or tetranitromethylamine, whereby a much stronger initial effect is obtained and one part of mercury fulminate is made to detonate a charge that would have required six times as much fulminate used alone. Other substances have been found also which seem likely to replace mercury fulminate entirely for certain uses. One of these is lead azide, a salt of hydronitric acid. Large dry crystals of this salt are so sensitive as to explode when brushed with a feather, but smaller crystals are less sensitive. Other proposed substitutes are lead styphnate, $PbC_6(NO_2)_{12}O_2$; hexamethylamine triperoxidediamine, $N(CH_2O.OH_2C)_3N$, said to be four or five times as strong as mercury fulminate; nitrogen tetrasulphide, N_4S_4; diazobenzolnitrate, $C_6H_5N_2(NO_3)$; basic mercury nitromethane; and perchlorate of trimercuraldehyde.[2]

As mercuric sulphide, mercury forms the brilliant red pigment vermilion. The metal is employed extensively in electrical apparatus, including rectifiers for changing alternating into direct current, mercury-vapor lamps and storage batteries. In the manufacture of felt hats from rabbit's fur, mercuric nitrate is used to roughen the hairs so that they will adhere together, a process technically known as "carroting." Metallic quicksilver is employed in the amalgamation of gold and silver ores, although of late years the wide application of the cyanide process has decreased this use. In the metallic state also the metal is utilized in the manufacture of instruments, thermostats, gas governors, and other appliances. Mercury enters into the composition of some antifouling marine paints for ship bottoms, a modern and at present a rapidly increasing use. The mercury for this purpose is generally employed as the red mercuric oxide, its efficacy depending upon the gradual conversion of the oxide to the poisonous bichloride by the sodium chloride of salt water. About 12 ounces of mercuric oxide or 11 ounces of metallic mercury is contained in each gallon of paint, which covers 243 square feet. Mercury is also used in certain compounds for preventing boiler scale, in cosmetics, and in dental amalgam. Silver nitrate has to a large extent been substituted for mercury in silvering mirrors. A small quantity of quicksilver, not more than 2 or 3 flasks annually, is used in floating certain types of revolving lights in lighthouses. The quicksilver so used, like that in some instruments and appliances, such as gas governors, is not consumed in the ordinary course of events, and additional quantities are required only when new installations are made. Quicksilver is also used as the cathode in certain electrolytic processes for manufacturing chlorine and caustic soda from common salt. The quicksilver combines with metallic sodium as sodium amalgam, which, in the presence of water, immediately reacts and forms metallic mercury and sodium hydrate. Mercuric oxide parts with oxygen readily and is a useful oxidizing agent in certain chemical processes. An important modern utilization of this property is in the manufacture of glacial acetic acid by the oxidation of acetylene.

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[1] Detailed specifications for mercury fulminate for military use have been prepared for the Ordnance Department, U. S. A., by H. C. Pritham, chief chemist, Frankford Arsenal; Dr. C. G. Storm, design section, Ordnance Department; and Capt. Paul McMichael, design section. Ordnance Department.

[2] Most of the statements in this paragraph are taken from a paper by Walter Arthur (Initiation of explosives: Jour. Ind. and Eng. Chemistry, vol. 9, pp. 392-395, 1917). Some of the chemical formulas are too complex to reproduce here.

As mentioned in the report for 1917, experiments have been carried out on a considerable scale to determine the possible advantage of using mercury vapor in tandem mercury and steam boilers with turbine power generators. No additional details concerning these experiments were published in 1918.

During the war mercurous nitrate and mercuric chloride, or corrosive sublimate, were used extensively in testing brass artillery cases and fuses. The articles to be tested are immersed for 15 minutes in the nitrate solution or for 4 hours in the chloride solution and are then examined for such cracks as may have been made visible by the action of the solution.

From data collected chiefly by J. P. Dunlop, under the supervision of H. D. McCaskey, both of the Geological Survey, it was estimated that the principal purposes for which quicksilver was used in the United States in 1917 were as follows:

Quicksilver used for certain purposes in 1917.

	Flasks of 75 pounds.
Drugs and chemicals	8,500
Fulminate	4,850
Vermilion	3,130
Oxide (for antifouling marine paint)	3,000
Electrical apparatus (batteries, electrolyzers, rectifiers, lamps, etc.)	2,700
Felt manufacture (especially hats)	1,700
Gold and silver amalgamating mills	850
Instruments, thermostats, gas governors, automatic sprinklers, etc	630
Miscellaneous, including boiler compounds and cosmetics	1,000
	26,360

In the following table the sum of the domestic production and imports less the exports is shown as apparent consumption. The apparent consumption in 1917 exceeded the total of the foregoing estimate by 4,228 flasks. Although this difference may represent quicksilver held in stock by dealers or users, it indicates that the estimates for the various uses are probably under rather than above the true figures. The apparent consumption in 1918 was 36,504 flasks, or nearly 6,000 flasks greater than in 1917, so that there was probably more quicksilver consumed in the industries of the United States, including the making of munitions, in 1918 than in 1917. The makers of vermilion and felt, however, appear to have used about 25 per cent less quicksilver than in 1917.

Supplies of quicksilver in the United States, 1913–1918.

Year.	Production.		Imports.		Exports.		Apparent consumption.	
	Quantity (flasks).	Value.	Quantity (flasks).	Value.	Quantity (flasks).	Value.	Quantity (flasks).	Value.
1913	20,213	$813,171	2,289	$75,361	1,140	$43,574	21,362	$844,958
1914	16,548	811,680	8,168	271,984	1,446	70,753	23,300	1,012,911
1915	21,033	1,804,631	5,625	282,752	3,372	225,509	23,286	1,861,874
1916	29,932	3,768,139	5,659	515,919	8,880	670,475	26,711	3,613,583
1917	36,159	3,808,266	5,207	448,032	10,778	998,470	30,588	3,257,828
1918	32,883	3,863,752	6,719	533,622	3,098	338,620	36,504	4,058,754

CONSUMPTION OF QUICKSILVER IN GOLD AND SILVER MINING.

Quicksilver is utilized to amalgamate with and retain native gold, both in quartz milling and in placer mining. Under ideal conditions the metal so employed would be recoverable and could be used over and over. In practice, however, there is some loss, which, according to Sharwood,[a] who has given this subject careful study, usually ranges from 0.005 to 0.01 pound avoirdupois, or from 0.07 to 0.15 ounce troy, to each ton of low-grade ore treated in modern mills. The following table gives approximately this loss for each State, including probably some quicksilver purchased during the year for new or enlarged milling operations. The figures given for Alaska are the least reliable, as they are based for the most part on statements of the cost of the quicksilver consumed annually in the large mills on Douglas Island with small, arbitrarily assumed additions for the smaller mills in the Territory. In the summer of 1916 amalgamation on Douglas Island was replaced by the cyanide process.

Quicksilver consumed in gold-quartz milling in United States, 1913–1917, in pounds.

State.	1913	1914	1915	1916	1917
Alaska	[b] 7,500	[b] 7,500	[b] 5,750	[b] 7,750	[b] 7,500
Arizona	[c] 1,500	[d] 1,802	[d] 547	[d] 645	[d] 205
California	[e] 17,000	[e] 17,500	[e] 19,600	[e] 19,300	[e] 18,400
Colorado	[f] 10,834	[f] 6,059	[f] 6,014	[f] 5,237	....
Idaho	[g] 254	[g] 598	[g] 1,040	[g] 1,183	[g] 1,035
Montana	[c] 200	[d] 408	[d] 371	[c] 206	[d] 167
Nevada	[c] 1,600	[c] 6,826	[d] 4,367	[d] 2,111	[d] 839
New Mexico	[f] 133	[f] 365	[f] 368	[f] 280	....
Oregon	[c] 350	[c] 400	[e] 1,690	[e] 3,700	[e] 2,687
South Dakota	[f] 12,160	[f] 13,500	[f] 13,900	[f] 12,516	[f] 13,199
Utah	[c] 30	[c] 20	[d] 30	[d] 15	[d] 5
Washington	[g] 130	[g] 43	[g] 28	[g] 317	[g] 185
	51,691	55,021	53,705	53,260	....

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[a] Sharwood, W. J., Loss of quicksilver in gold mills: Min. and Sci. Press, Apr. 6, 1918, p. 483.

[b] Rough estimate based on cost of quicksilver consumed as given in annual reports of Alaska gold-mining companies (F. L. Ransome).

[c] Estimate based on bullion produced by amalgamation (H. D. McCaskey).

[d] Heikes, V. C., U. S. Geol. Survey Mineral Resources, 1913–1917.

[e] Estimate based on bullion produced by amalgamation (F. L. Ransome).

[f] Henderson, C. W., U. S. Geol. Survey Mineral Resources, 1913–1917.

[g] Gerry, C. N., idem.

The quantity of quicksilver used in sluicing, hydraulic mining, and dredging, and the proportion of it lost, vary widely with the character of the gravel and the coarseness of the gold. In modern gold dredging the quantity lost annually by each dredge is very small, and according to William S. Noyes,[1] of the El Oro Dredging Co., averages, roughly, about a flask. An attempt was made to estimate the quantity lost annually in placer mining in each State and to prepare for this branch of the mining industry a table similar to that just given, but the data available proved insufficient for this purpose. Probably from 15,000 to 20,000 pounds, or from 200 to 265 flasks, is lost annually in California in placer mining, including dredging, and possibly twice as much in the country as a whole.

GENERAL GEOGRAPHIC AND GEOLOGIC RELATIONS OF QUICKSILVER DEPOSITS.

The distribution and mode of occurrence of quicksilver deposits were treated rather fully in the report for 1917, and that information will not be repeated here. No new deposits of consequence were found in 1918.

Appended to this report is a table in which are listed the quicksilver mines of the United States, with brief notes on the character and geologic relations of the ore bodies and data concerning development, equipment, and production.

From the data assembled in this chart the approximate proportions of the total output of quicksilver obtained in the United States from various rocks, or groups of rocks, is as follows:

	Per cent.
Serpentine, associated with the early Cretaceous or late Jurassic Franciscan group of the Pacific coast	64
Sandstones and shales of the Franciscan group and subordinately of the Cretaceous Knoxville shale, the ore generally close to serpentine	21
Radiolarian chert, of the Franciscan group	5
Tertiary and younger volcanic rocks, chiefly basalt and andesite in the Coast Ranges and rhyolite in Nevada	5
Limestones and calcareous shales, chiefly the Cretaceous of Texas, but subordinately early Mesozoic limestones in Nevada	3
Tertiary sandstone, pre-Cambrian schist	2
	100

It appears that about 90 per cent of all the quicksilver mined in the United States has come from the serpentine and the intimately associated sedimentary rocks of the Franciscan group, with which, in the present inquiry, is included some Knoxville shale.

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[1] Letter, Aug. 12, 1918.

MINERALOGY OF QUICKSILVER ORES.

GENERAL CHARACTER OF ORES.

Quicksilver ores as a rule are comparatively simple in mineralogical character. About 25 mercurial minerals are known, but most of them are rare, and to few quicksilver miners does "quicksilver ore" suggest anything but rock containing the brilliant red sulphide cinnabar, with perhaps some native mercury and possibly a little of the black or dark-gray sulphide metacinnabar. These minerals are commonly associated with more or less iron sulphide in the form of pyrite or marcasite. The mercury minerals and associated sulphides may be scattered in small specks through sandstone or other porous rock; they may occur as irregular streaks or bunches in altered rocks of various kinds; or, with calcite, barite, or quartz as gangue minerals, they may form definite veins, although these are rarely of regular form.

A large number of the deposits in California are in serpentine, and in these the cinnabar and accompanying sulphides occur in dark opal or in carbonates of calcium, magnesium, and iron, or in mixtures of opal and carbonates. In Nevada many of the deposits are in rhyolite, which in the vicinity of the cinnabar is generally much altered. In some localities the rhyolite has been changed to a very hard granular rock resembling quartzite, in others it has been converted to white opal, and in others to soft masses of sericite or kaolinite. Various mixtures of these minerals are also common.

In certain localities the sulphide of antimony, stibnite, is fairly abundant with the cinnabar, and most quicksilver deposits, especially in California, contain small quantities of an oily or asphaltio hydrocarbon.

MINERALS CONTAINING MERCURY.

The mineralogy of quicksilver deposits was fully described in the report for 1917, copies of which are still available for distribution.

TENOR OF ORES.

The richest quicksilver ores worked on a large scale are those of Almaden, Spain, where the average content won from the ore in 1917 was nearly 7 per cent and where the average of some ore bodies is stated to be as high as 25 per cent. Probably the lowest tenor in ores that are successfully worked is found on the Pacific coast of the United States. The average content won from the California ores in 1916 and 1917 was 0.38 per cent. In 1918 it was only 0.24 per cent, and the average in furnace operations was 0.30 per cent. In Texas, in 1918, the average for furnace ore was 0.87 per cent and for ore treated in retorts 0.88 per cent. The average for all ore treated in furnaces in the United States in 1918 was 0.37 per cent. The ore at Idria, Austria, according to the latest information available, averages about 0.65 per cent. In the Monte Amiata district, Italy, the ores are reported to range in tenor from 0.25 to 30 per cent, the average for the district in 1913 being 0.89 per cent.

QUICKSILVER-MINING INDUSTRY BY STATES.

ALASKA.

No production has been recorded from Alaska, although it is possible that a little quicksilver was produced for local use from deposits in the central Kuskokwim region, briefly described in the report on quicksilver for 1917.

ARIZONA.

Arizona produced no quicksilver in 1918, although prospecting was in progress in the Phoenix Mountains, Maricopa County, on deposits described by F. C. Schrader[1] as shear zones in schist, carrying cinnabar, metacinnabar, and a little native quicksilver, with quartz, calcite, and iron oxide, the last presumably from pyrite or marcasite. The principal lodes, three in number, strike northeast to north-northeast, and the most extensive development work at the end of the year was a shaft 100 feet deep with crosscuts at 70 and 100 feet. Another shaft was down 45 feet at the end of the year. The deposits are similar in character to those in the Mazatzal Range and have the advantage of greater accessibility.

CALIFORNIA.

PRODUCTION.

Quicksilver mining continued fairly active in California in 1918, although the generally decreasing tenor of the ore and the prospect of lower prices for quicksilver in 1919 led to the closing of some mines near the end of the year. The production of the State was 22,664 flasks in 1918, valued at $2,663,020. Of this 20,279 flasks was reduced in furnaces, 1,985 flasks in retorts, and 400 flasks recovered by washing. The output in 1917 was 23,938 flasks, valued at $2,521,151. There was therefore in 1918 a falling off of 1,274 flasks, or 5.32 per cent, as compared with 1917, but an increase in the total value of $141,869, or 5.63 per cent. In total value the output exceeded that of any other year since 1877. California produced 68.92 per cent of the total quicksilver output of the country for 1918.

In the following table, which gives the annual yield of quicksilver in California from 1850, when production began, to date, the quantities are recorded in flasks of 76½ pounds to June, 1904, since when they are given as the present standard domestic flasks of 75 pounds.

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[1] Schrader, F. C., Quicksilver deposits of the Phoenix Mountains, Ariz.: U. S. Geol. Survey Bull. 690, pp. 95-110, 1918.

Quicksilver produced in California, 1850–1918.

Year.	Flasks.	Price per flask.	Value.	Year.	Flasks.	Price per flask.	Value.
1850	7,723	$99.45	$768,052	1886	29,981	$35.50	$1,064,325
1851	27,779	66.93	1,859,248	1887	33,760	42.375	1,430,580
1852	20,000	58.33	1,166,600	1888	33,250	42.50	1,370,625
1853	22,284	55.45	1,235,648	1889	26,464	45.00	1,190,880
1854	30,004	55.45	1,663,722	1890	22,926	52.50	1,203,615
1855	33,000	53.55	1,767,150	1891	22,904	45.25	1,036,406
1856	30,000	51.65	1,549,500	1892	27,993	40.71	1,139,595
1857	28,204	48.73	1,374,381	1893	30,164	36.75	1,108,527
1858	31,000	47.83	1,482,730	1894	30,416	30.70	933,771
1859	13,000	63.13	820,690	1895	36,067	37.04	1,335,922
1860	10,000	53.55	535,500	1896	30,765	34.96	1,075,544
1861	35,000	42.05	1,471,750	1897	26,691	37.28	995,040
1862	42,000	36.35	1,526,700	1898	31,092	38.23	1,188,647
1863	40,531	42.08	1,705,544	1899	29,454	47.70	1,404,956
1864	47,489	45.90	2,179,745	1900	26,317	44.94	1,182,686
1865	53,000	45.90	2,432,700	1901	26,720	48.46	1,294,851
1866	46,550	53.13	2,473,202	1902	28,972	43.20	1,251,590
1867	47,000	45.90	2,157,300	1903	30,526	45.29	1,382,523
1868	47,728	45.90	2,190,715	1904	29,217	43.50	1,270,940
1869	33,811	45.90	1,551,925	1905	24,635	36.22	892,280
1870	30,077	57.38	1,725,818	1906	20,310	39.50	802,245
1871	31,686	63.10	1,999,387	1907	17,431	39.60	690,268
1872	31,621	65.93	2,084,773	1908	16,984	44.17	750,183
1873	27,642	80.33	2,220,482	1909	16,078	45.45	730,745
1874	27,756	105.18	2,919,376	1910	17,211	46.51	800,484
1875	50,250	84.15	4,228,538	1911	18,860	46.01	867,749
1876	72,716	44.00	3,199,504	1912	20,524	42.05	863,034
1877	79,395	37.30	2,961,434	1913	15,591	40.23	627,228
1878	63,880	32.90	2,101,652	1914	11,303	49.05	554,414
1879	73,684	29.85	2,199,467	1915	14,283	85.80	1,225,481
1880	59,926	31.00	1,857,706	1916	21,045	125.89	2,649,355
1881	60,851	29.83	1,815,185	1917	23,938	105.32	2,521,151
1882	52,682	28.23	1,487,213	1918	22,664	117.50	2,663,020
1883	46,725	28.75	1,343,344				
1884	31,913	30.50	973,347		2,233,516	....	105,514,933
1885	32,073	30.75	986.245				

As usual, San Benito County, in which are situated the New Idria workings, at present the most productive mine in the Western Hemisphere, leads, with nearly half of the total output of the State. It is followed by Santa Clara County, which contains the New Almaden, the largest, deepest, and in total output, the most productive quicksilver mine in California, and the New Guadalupe mine. Third in rank is Sonoma County, with the Cloverdale, Great Eastern, Culver-Baer, and Socrates mines. San Luis Obispo County, in which the Oceanic was the leading mine in 1918, comes fourth, and Lake County with the Sulphur Bank, Helen, and Big Chief as leading producers but with a number of famous old mines now idle, ranks fifth. Napa County, also containing many old mines that contributed largely to the production of the State in past years, now holds sixth place.

Thirty-three operators reported production in California in 1918. Of these, 2, the New Almaden Co. (Inc.) and the New Idria Quicksilver Mining Co. were each conducting productive operations at two distinct mines at adjacent localities under one management, and a third, the Patriquin Mining Co., reported separately production from two mines in adjoining counties. At 16 localities the metal was obtained by furnace reduction from mines having as a rule considerable development, although at only 4 of them was the ore hoisted by machinery. At 3 of these mines some ore was retorted in addition to that put through furnaces. At 16 localities quicksilver was won by retorts from mines generally but not invariably less developed than those equipped with furnaces. At 3 localities it was recovered entirely from salvage operations on old dumps or reduction works, usually by gravity concentration and retorting; and at one locality by steam-shovel work on old dumps, followed by gravity concentration and retorting. Altogether, there was mined or handled about 362,122 tons of ore, of which 355,000 tons was treated. About 87,500 tons of this material was moved with a steam shovel at Sulphur Bank. Of the ore treated, 249,399 tons was sent through furnaces and 4,910 tons of new ore and dump concentrates was retorted. At New Almaden 400 flasks of quicksilver was recovered by passing through a washer 13,191 tons of material excavated from the sites of old furnaces.

Quicksilver produced in California, 1918, by counties.

County.	Quantity (flasks of 75 pounds).	Value.
Lake	1,540	$180,950.00
Napa	1,289	151,457.50
San Benito	10,700	1,257,250.00
Santa Barbara	27	3,172.50
Santa Clara	3,977	467,297.50
Solano	593	69,677.50
Sonoma	2,478	291,165.00
Yolo	113	13,277.50
Others[a]	1,947	228,772.50
	22,664	2,663,020.00

[a] Includes Fresno, Kern, Kings, Monterey, San Luis Obispo, Siskiyou, and Trinity counties, in each of which there was only a single mine productive. Approximately three-fourths of the output here combined was from San Luis Obispo County.

COLUSA COUNTY.

The mines of the Sulphur Creek district, near Wilbur Springs, remained idle throughout the year.

FRESNO COUNTY.

At the Mercy mine, in the northwest corner of the county, the 20-ton Scott furnace was run for a few days in April and a small production was made. A few flasks of quicksilver was produced also at the Archer mine, about 18 miles northwest of Coalinga.

KERN COUNTY.

The Cuddeback mine, about half a mile northeast of Tehachapi Loop, on the Southern Pacific Railroad, near Keene, was productive up to the end of November, when operations are understood to have ceased.

KINGS COUNTY.

Near the end of the year the Patriquin Mining Co., which had been operating the Patriquin mine near Parkfield, in Monterey County, leased the NW. ¼ sec. 28, T. 23 S., R. 16 E. Mount Diablo meridian, owned by H. Dawson, of Lemoore, Calif. At the end of the year the company was drifting in ore from the bottom of a 50-foot shaft and treating this ore in the 10-ton Scott furnace of the Kings mine, about 2 miles away. The ore body is described by the lessee company as apparently large and of good grade.

LAKE COUNTY.

By far the largest output in Lake County in 1918 was made by the Sulphur Bank mine, at which the ore was handled by a steam shovel, concentrated, and retorted. A rotary furnace was in operation during part of the year, but was not entirely successful on account of the large proportion of free sulphur in the ore. This sulphur, instead of burning in the furnace, was in large part sublimed and carried into the condensers. The remainder of the county's production came most entirely from the Helen and Big Chief mines, although the Baker and Wall Street mines each yielded a few flasks.

MONTEREY COUNTY.

The Patriquin mine near Parkfield produced some quicksilver, but operations at this mine ceased near the end of the year.

NAPA COUNTY.

The output from Napa County in 1918 came chiefly from the Aetna mine, operated by the California Mines Development Corporation. Power drills were installed by this company during the year and it was hoped that the production might be considerably increased in 1919. The mine was closed, however, at the end of the year, as it was found impossible to work it at a profit under present conditions. A considerably smaller yield was made by the La Joya mine, and outputs of less than 75 flasks each were made from the Rutherford (Bella Union) and Twin Peaks mines and from the dumps at Oat Hill. A rotary furnace 4 feet in diameter and 56 feet long was put up at the Rutherford mine in 1918, but does not appear to have been used during the year. Exploratory work continued in the Oat Hill mine and a 50-ton furnace was erected during the year but was not operated.

SAN BENITO COUNTY.

The only mines in San Benito County from which any production of quicksilver was reported in 1918 were the jointly operated New Idria and San Carlos mines. At New Idria one rotary furnace 4 feet in diameter and four similar furnaces 5 feet in diameter, all 56 feet long, were completed during the year and have been in successful use. The 60-ton Scott furnace was put out of commission on November 1, 1918. A new aerial tramway was also completed during the year.

At the Stayton mine, in the Stayton district, a rotary furnace was put up, but had not been completed at the end of the year.

SAN LUIS OBISPO COUNTY.

The Oceanic, 5 miles east of Cambria, was the only quicksilver mine productive in San Luis Obispo County in 1918, and one of its two 50-ton furnaces was put out of commission at the end of the year.

SANTA BARBARA COUNTY.

A very small production was made in Santa Barbara County from retorted ore at the Red Rock or Acachuma mine and from the Santa

Ynez or Townsend claims on the Los Prietos lode, in the El Montecito district. Considerable preparatory work was done during the year on the Milburn-McAvoy ground in the same district.

SANTA CLARA COUNTY.

At New Almaden the principal output, as in 1917, was from the El Senador mine, about 4 miles northwest of the famous old workings in Mine Hill. A new 100-ton Scott furnace was put into operation in May, 1918, but was at no time during the year worked to its full capacity. Salvage work was continued at the old hacienda at the foot of Mine Hill and more than 500 flasks of quicksilver were obtained by washing. The average tenor of the material excavated from under old furnaces and condensers was 0.17 per cent. No underground work was reported in the New Almaden mine proper.

The New Guadalupe mine was operated throughout the year but yielded less than half as much quicksilver as in 1917. In the newer workings on the northeast side of Capitancillos Creek exploration and development had not kept pace with the extraction of ore and not enough ore was available in 1918 to keep up the previous rate of production. Although the old mine on the southwest side of the creek was partly unwatered during the year and a connection made with the new mine, no considerable production from the recovered workings had been made up to the end of the year.

SISKIYOU COUNTY.

On the Morgan & Herzog claims on upper Empire Creek, north of Gottville, W. A. Hutton erected two large D retorts near the end of the year and expected to begin the production of quicksilver in 1919.

SOLANO COUNTY.

The St. Johns mine continued to be productive although the president of the St. Johns Mines Co. stated that, owing to the unprecedented high cost of labor and supplies, the mine was operated at a loss during the latter part of the year. No record of production by the Hastings mine was received.

SONOMA COUNTY.

The Cloverdale mine, owned by the Western Mercury Co. (Inc.), was steadily productive throughout the year and made by far the largest output in the county. A new rotary furnace was installed which was expected to be ready for operation at the beginning of 1919. With this improvement the mine should be capable of a considerable increase in production.

The Great Eastern mine did not yield as much quicksilver as in 1917, although the quantity of ore mined was much larger. Development work was actively pushed during the year.

The Culver-Baer mine also produced less than in 1917.

The Socrates mine, although not continuously in operation and not under the same management for the whole of the year, produced a few hundred flasks and ranked third among the producing mines of Sonoma County.

A very small output was made by the Buckeye mine, 14 miles east of Cloverdale.

STANISLAUS COUNTY.

No production and no development work of importance was reported from Stanislaus County in 1918.

TRINITY COUNTY.

A very small production was made by lessees from the Altoona mine, near Castella, chiefly from old dumps.

YOLO COUNTY.

Operations at the January mine were hampered by lack of water for the concentrating mill. Some development work was carried on, and a 75-ton rotary furnace was installed which was expected to be ready for use early in 1919. The mine made a small production from ore mined in connection with development.

IDAHO.

The small production recorded from Idaho, 22 flasks, came from the Yellow Pine district in Valley County, chiefly from the Fern mine. These deposits were briefly described in the report for 1917.

NEVADA.

PRODUCTION.

The production of quicksilver in Nevada in 1918 was 1,044 flasks, valued at $122,670, against 997 flasks, valued at $105,004, in 1917. The number of operators reporting production was 4, as compared with 8 in 1917. In addition, 1 operator, estimated to have produced 10 flasks, was not heard from. The ore treated amounted to 11,078 tons and yielded 7 pounds to the ton, or 0.35 per cent, as against 3,639 tons that yielded 20.4 pounds to the ton, or 1.02 per cent, in 1917. There was thus an increase in the ore mined in 1918, but a decided decrease in its tenor.

By far the largest individual output was made by the Mercury Mining Co., operating near Ione.

Quicksilver produced in Nevada, 1903–1918.

Year.	Quantity (flasks).	Price per flask.	Value.	Year.	Quantity (flasks).	Price per flask.	Value.
1903	65	$45.29	$2,944	1912	2,550	$42.05	$107,228
1904	17	43.50	740	1913	1,645	40.23	66,178
1905	None.	36.22	....	1914	2,089	49.05	102,465
1906	None.	39.50	....	1915	2,327	85.80	199,657
1907	None.	39.60	....	1916	2,198	125.89	276,706
1908	None.	44.17	....	1917	997	105.32	105,004
1909	316	45.45	14,362	1918	1,044	117.50	122,670
1910	70	46.51	3,256				
1911	70	46.01	3,221		13,388	....	1,004,431

ELKO COUNTY.

No production was reported from the Ivanhoe Springs district in Elko County.

HUMBOLDT COUNTY.

At the Goldbanks mine[1] development was carried on from January 1 to May 31, but the furnace remained out of commission and no quicksilver was produced. The new shaft was sunk to 200 feet and crosscuts were run from this shaft and from a shaft under the formerly productive workings.

LANDER COUNTY.

Although no quicksilver was produced in Lander County considerable preparatory work was done by the Cinnabar Mines Co., which has acquired the Ruby group and some additional claims in an unorganized mining district, locally known as the Cinnabar district. According to a letter from Mr. John Ross, manager and member of the company, the mine is 75 miles south-southwest of Battle Mountain and 35 miles from Watts Siding on the Nevada Central Railroad. It apparently is in the New Pass Range. Mr. Ross writes (May 1, 1919) that 12 Johnson-McKay retorts have been set up and that about 500 feet of development work has been done.

MINERAL COUNTY.

In the Pilot Mountains, east of Mina, the principal production was made by the lessee of the Lost Steers ground. All of the ore was taken from shallow workings and was treated in a single D retort.

A little work was done during the year on a slightly developed deposit about 1½ miles northeast of Pilot Peak by Mr. E. Messenger, of Mina, who states that the best ore occurs in rhyolite and quartzite. He has produced a little quicksilver from time to time, but reported no output in 1918. Mr. Messenger also writes that Messrs. F. Fletcher and O. Galliher, both of Dyer, Nev., have nine claims immediately south of his ground and have opened up some good ore.

According to a newspaper report, Messrs. Sol Summerfield and Fritz Elges produced some quicksilver from the Farnham & Drew mine and from one other locality in the Pilot Mountains. Letters of inquiry concerning these reported operations failed, however, to bring any response.

At the Red Rose mine on Montgomery Mountain production was maintained until December, when the severe weather at the high altitude at which this mine is situated compelled the cessation of operations. The ore was reduced in 2 D retorts having an estimated capacity of 500 pounds.

NYE COUNTY.

The Mercury Mining Co. continued to operate its mine near Ione throughout the year and made by far the largest production in Nevada from its 25-ton Scott furnace. In addition to 1,260 feet of drifting that yielded some ore the mine was enlarged by more than 1,000 linear feet of development work.

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[1] Now in Pershing County, established March 18, 1919.

The adjacent Nevada Cinnabar mine was operated only for a short time in April, May, and June, and made a small output.

OREGON.

PRODUCTION.

The production of quicksilver in Oregon in 1918 amounted to 702 flasks, valued at $82,485, as against 388 flasks, valued at $40,864, in 1917. The Black Butte mine in Lane County produced more than in 1917 but the greater part of the increase was due to the operation of the Rainier mine in the Meadows district, in Jackson County.

JACKSON COUNTY.

So far as known, the Rainier mine was the only producer in Jackson County in 1918. The mine was operated by the Rainier Quicksilver Co. up to August and for the rest of the year was under lease to R. S. Jameson. The ore was reduced in 12 Johnson-McKay retorts.

LANE COUNTY.

The Black Butte mine was operated throughout the year, although for part of the time with a reduced force. The ore treated was, as usual, of low grade.

TEXAS.

PRODUCTION.

There were four producing mines in Texas in 1918, all in Brewster County. The ore treated amounted to 36,482 tons and yielded 8,451 flasks, valued at $992,992, as against 10,791 flasks, valued at $1,136,508, in 1917. The production of Texas from the beginning of operations in the Terlingua district to date is given in the following table:

Quicksilver produced in Texas, 1899–1918.

Year.	Quantity (flasks).	Price per flask.	Value.	Year.	Quantity (flasks).	Price per flask.	Value.
1899	1,000	$47.70	$47,700	1910	3,320	$46.51	$154,413
1900	1,800	44.94	80,892	1911	2,326	46.01	107,019
1901	2,932	48.46	142,085	1912	1,990	42.05	83,680
1902	5,319	43.20	229,781	1913	2,750	40.23	110,633
1903	5,029	45.29	227,763	1914	3,144	49.05	154,213
1904	5,336	43.50	232,116	1915	4,417	85.80	378,979
1905	4,723	36.22	171,067	1916	6,306	125.89	793,862
1906	4,761	39.50	188,060	1917	10,791	105.32	1,136,508
1907	3,686	39.60	145,966	1918	8,451	117.50	992,992
1908	2,382	44.17	105.213				
1909	4,188	45.45	190,345		84,651	....	5,673,287

BREWSTER COUNTY.

The Chisos mine in the Terlingua district was operated throughout the year and was by far the most productive quicksilver mine in

Texas, although its output was less than in 1917. Only one mine in the United States, the New Idria, in California, yielded more quicksilver during the year.

The rotary furnace at the Chisos was in operation for part of the year, but by far the greater part of the ore was reduced in the 20-ton Scott furnace.

At the Mariposa mine operations were hampered by shortage of labor and great difficulty in obtaining sufficient fuel, which is all hauled from Mexico. The two 10-ton Scott furnaces were placed out of commission early in July and the 50-ton furnace of the Terlingua Mining Co., leased to the Mariposa Mining Co., was operated for the last five months of the year on ore from both Mariposa and Terlingua ground.

At the Big Bend mine, at Study Butte, work was confined to the apparently nearly exhausted ground above water level, which yielded a little over half of the output for the previous year. Pumping was in progress in conjunction with the unwatering of the adjoining Texas-Almaden mine and it was expected that a new level in the Big Bend would be opened by February, 1919.

At the Texas-Almaden mine operations were confined to pumping. There is evidently a large body of underground water and progress is slow, although the gains are reported to be easily held.

Apparently the only prospecting carried on in the Terlingua district outside of the productive mines was the work of the Rainbow Mining Co., which at the end of the year had a shaft 230 feet deep about 600 feet west of the westernmost shaft of the Chisos mine and on the same fissure zone.

The Ellis mine, 6 miles from McKinney Springs, nearly doubled its production in 1917.

QUICKSILVER MINES IN THE UNITED STATES.

Mine.	County.	Post office.	Operator or owner, and address.	Character of deposit.	Workings.	Reduction equipment.	Production to end of 1918.	Remarks.
ARIZONA.							*Flasks.*	
Sunflower	Maricopa	Phoenix (70 miles northeast by road).	Sunflower Cinnabar Mining Co., 356 Third Avenue north, Phoenix., Ariz.	Cinnabar and calcite in shear zones in pre-Cambrian schist.	Tunnels and cuts.	10 Johnson-McKay retorts.	Less than 50.	Idle.
Colonial	Yuma	Quartzsite (8 miles southwest).	Cinnabar Development Co., Peoples' Gas Building, Chicago, Ill.	Vein in pre-Cambrian schist.	300-foot shaft and drifts.	36-ton Scott furnace.	258	Idle since 1914.
CALIFORNIA.								
Central	Colusa	Wilbur Springs	Dr. E. B. (Mrs. R. A.) Boggess, 715 French Bank Building, San Francisco, Calif.	Cinnabar disseminated irregularly through altered serpentine near contact witk Knoxville shale.	Not accessible	None; was operated with Manzanita.	Unknown; probably about 100.	Idle for years.
Elgin	do	Wilbur Springs (3 miles west-northwest).	New Elgin Quicksilver Mining Co. (W. S. Norman), Spokane, Wash.	Cinnabar disseminated through tongue of altered serpentine in Cretaceous shale and sandstone.	Tunnels; not accessible.		About 300	Practically idle since 1909.
Empire	do	Wilbur Springs (one-half mile southwest).	Dr. E. B. (Mrs. R. A.) Boggess, 715 French Bank Building, San Francisco, Calif.	Cinnabar in serpentine near contact with Knoxville shale.	Shaft and tunnel; inaccessible.	None; was operated with Abbott.	Probably no production.	Idle for years.
Manzanita	do	Wilbur Springs (one-half mile west).	J. W. Cuthbert, owner; Cerise Gold Mining Co., lessee, both Wilbur Springs, Calif.	Veins and irregular disseminated deposits in sandstone and shale (Franciscan? formation).	Open cut and tunnels.	Concentrator and retorts; dismantled.	About 2,000	Do.
Wide Awake	do	Wilbur Springs (three-fourth mile southwest).	A. A. Gibson and G. A. Martin, Wilbur Springs, Calif.	Cinnabar irregularly disseminated and in stringers in altered serpentine near contact with Knoxville shale.	Open cut, tunnels and 500-foot shaft and levels.	24-ton Scott furnace.	About 500	Idle since 1901.
Wilbur Hill	do	Wilbur Springs	J. W. Cuthbert, Wilbur Springs, Calif.	Cinnabar disseminated and in stringers in altered serpentine.	Short tunnels	None	Small; probably less than 100.	Idle.

Quicksilver mines in the United States—Continued.

Mine.	County.	Post office.	Operator or owner, and address.	Character of deposit.	Workings.	Reduction equipment.	Production to end of 1918.	Remarks.
CALIFORNIA—con.							*Flasks.*	
Bernard (Amador)	Eldorado	Diamond Spring (8 miles south).	Bernard Cinnabar Mining Co., 127 Montgomery Street, San Francisco, Calif.	Impregnated bed of sandstone between slates. Calaveras formation.	Shallow shaft and tunnel.	None	No record; small.	Idle for years.
Mercy (Pacific)	Fresno	South Dos Palos, Merced County (18 miles southwest).	New Mercy Mining & Development Co., 215 Florinda Street West, Hanford, Calif.	On Arambide claim, cinnabar disseminated and in stringers forming irregular ore shoots in serpentine. On Aurecoechea claim, cinnabar associated with veins and stringers of quarts in shale and sandstone of Franciscan formation.	On Arambide claim, open cut, 100-foot shaft and about 400 feet of tunnel. On Aurecoechea claim, 150-foot shaft and about 3,000 feet tunnels and drifts.	20-ton Scott furnace, 2 D retorts.	903	Operation desultory during past few years; production prior to 1900 unknown.
Mexican (Del Mexico).	do	Coalinga (20 miles southwest).	Jas. G. Rhodes, Coalinga, Calif.	Cinnabar in joints in sandstone of Franciscan formation near serpentine.	Short cuts and tunnels.	Retorts; dismantled.	Unknown	Idle for many years.
Cuddeback	Kern	Keene	Cuddeback Cinnabar Co., Tehachapi, Calif.	Rhyolite dike in granite, containing cinnabar irregularly disseminated near fissures.	Open cuts and tunnels.	12 12-inch Johnson-McKay retorts.	414	
Dawson	Kings	Parkfield, Monterey County (15 miles east).	H. Dawson, owner, Lemore, Calif.; Patriquin Mining Co., lessee, Parkfield, Calif.	Probably in serpentine; no details.	50-foot shaft and drifts.	None; ore reduced at Kings mine.	41	Development begun late in 1918.
Kings	do	Parkfield, Monterey County (14 miles east by road).	Kings Quicksilver Mining Co. (Ltd.), owner, 520 King Street, London, Ontario, Canada; Patriquin Mining Co., lessee, Parkfield, Calif.	Cinnabar and native quicksilver, probably in serpentine.	No details	10-ton Scott furnace.	500	Idle; furnace used on Dawson ore.
Abbott (and Disturnell).	Lake	Wilbur Springs, Colusa County (2 miles south).	Alpha Quicksilver Co. (R. A. Boggess), French Bank Building, San Francisco, Calif.	Cinnabar disseminated in much altered crushed, serpentinized dikes in Knoxville shale.	Open cut, tunnels, 350-foot shaft, and levels; about 15,000 feet in all.	50-ton Scott furnace.	About 30,500	Idle; workings mostly inaccessible.

Baker	do	Lower Lake (6 miles southeast).	Baker Quicksilver Co., 17 West Santa Clara Street, San Jose, Calif.	Cinnabar disseminated in dike of serpentine in Knoxville shale.	Open cut, tunnels, and 100-foot inclined shaft.	Concentrating table, 5 10-inch Johnson-McKay retorts; capacity, 1,000 pounds.	Small; probably less than 300.	Idle at end of 1918.
Big Chief	do	Middletown (5 miles northwest).	R. B. Crowell, Middletown, Calif.	Cinnabar on fracture planes in radiolarian chert of Franciscan group.	Tunnels	Ore reduced at Big Injun.	200	
Big Injun (and Digger Injun).	do	do	do	Native quicksilver and cinnabar disseminated and in veinlets in serpentine near fissure zone.	Tunnels and open cut	2 D retorts, 1 concentrating table.	Probably less than 500.	Idle at end of 1918; retorts used for Big Chief ore.
Chicago (Ural)	do	Middletown (6½ miles west).	Chicago Quicksilver Mining Co., San Jose, Calif.	In serpentine	Tunnels	15-ton concrete furnace of Scott type; never used.	None recorded	Idle.
Great Western	do	Middletown (4 miles southwest).	Unknown	Cinnabar in fractured radiolarian chert of the Franciscan group, near serpentine.	Shafts and tunnels 750 feet deep, with about 18,000 feet of drifts.	40-ton Litchfield furnace.	101,275	Abandoned; plant dismantled.
Helen (American)	do	Middletown (6 miles west).	Andrew Rocca, Middletown, Calif.	Cinnabar in bunches and stringers in opalized serpentine.	Tunnels; about 5,000 feet of drifts and crosscuts.	50-ton Scott furnace; 700-pound D retort.	About 7,000	5,295 flasks from 1902 to 1918, inclusive.
Lucitta	do	Kelseyville (about 7 miles southeast).	Mount Sam Mining Co., Napa, Calif.	Cinnabar in fissured dacite.	About 1,200 feet of tunnels.	10 Johnson-McKay retorts.	Small; probably less than 300.	
Mirabel (Bradford)	do	Middletown (4 miles south).	Standard Quicksilver Co., 453 Mills Building, San Francisco, Calif.	Cinnabar in altered serpentine near contact with sandstone of Franciscan group.	Shaft and about 23,000 feet of levels 500 feet deep.	40-ton Scott furnace.	31,500	Idle; no deep work done since 1897.
Sulphur Bank	do	Lower Lake (about 10 miles north).	G. T. Ruddock, owner, 433 California Street, San Francisco; Sulphur Bank Association, lessee, 608 Crocker Building, San Francisco.	Cinnibar and sulphur disseminated and in stringers in solfatarically altered basalt and in underlying Quaternary lake beds and in sandstone of the Franciscan group.	Large open cuts, shafts to about 300 feet and fairly extensive levels.	Steam shovel, 300-ton concentrating mill; rotary furnace; 4 D retorts, 24 Johnson-McKay retorts.	About 95,000	Old furnace equipment dismantled and underground workings full of water.
Wall Street	do	Middletown (5½ miles west).	W. H. Parsons, Middletown, Calif.	Native quicksilver and cinnabar irregularly disseminated in altered serpentine.	Tunnels	1 4-ton furnace, 1 600-pound D retort, 1 concentrating table.	350	

Quicksilver mines in the United States—Continued.

Mine.	County.	Post office.	Operator or owner, and address.	Character of deposit.	Workings.	Reduction equipment.	Production to end of 1918.	Remarks.
CALIFORNIA—con.							*Flasks.*	
Patriquin (Cholame, Parkfield, Pitts).	Monterey	Parkfield (5 miles north).	Patriquin Mining Co., Parkfield, Calif.	Cinnabar disseminated and in bunches in altered serpentine. Ore bodies very irregular.	Cuts and tunnels	24 12-inch Johnson-McKay retorts, capacity about 3 tons; 1 D retort.	Probably about 1,000.	899 flasks since 1914.
Aetna (includes Phoenix Silver Bow, Red Hill, Star, Pope, and Washington mines).	Napa	Aetna Springs	H. B. & C. A. Lawley, owners, Calistoga, Calif; California Mines Development Corp., lessee, 728 Monadnock Building, San Francisco, Calif.	Phoenix workings: Cinnabar disseminated and as stringers in serpentine along zones of fissuring. Silver Bow and Star: Cinnibar disseminated through altered basalt dikes.	Extensive; open cuts, tunnels, and shafts. Deepest shaft, the Star, 800 feet; longest tunnel, No. 7, 7,226 feet.	48-ton Scott furnace.	On record 45,661. In early eighties output was combined with that of Oat Hill. Production during these and earlier years estimated at 10,000, making total output 55,661.	
Corona	do	Middletown, Lake County, Calif. (9 miles southeast).	Vallejo Quicksilver Mining Co., Vallejo, Calif.	Cinnabar disseminated and as stringers in opalized serpentine near contact with sandstone of the Franciscan group.	Tunnels and winze	50-ton furnace of Scott type.	Reported to have yielded quicksilver to value of $250,000, or about 6,000.	Idle since 1906.
Knoxville (Excelsior, Redington, Boston).	do	Monticello (20 miles north-northwest).	Unknown	Cinnabar and metacinnabar in opalized serpentine.	Three shafts and extensive levels; depth 600 feet.	Furnaces dismantled.	Recorded 117,987; estimated 1893–1895, inclusive, 3,000; total 120,987.	Idle.
La Joya	do	Oakville (7 miles west).	James Rennie, Olympic Club, San Francisco.	Cinnabar disseminated and in veinlets in serpentine.	Tunnels	Fitzgerald 12-ton furnace; Livingston 8-ton furnace; 12 Johnson-McKay retorts; capacity 3 tons.	Small, probably less than 1,500.	
Manhattan (Lake).	do	Monticello (21 miles north-northwest).	Lake Mining Co., care of R. B. Knox, 3015 Hillegas Avenue, Berkeley, Calif.	Cinnabar in chalcedonized tuff, in altered "basalt" and in "mud-rock" (shale?).	Open cuts, tunnels, and shafts.	1 24-ton coarse-ore Knox-Osborne furnace, and 1 24-ton fine-ore Knox-Osborne furnace.	15,933	Idle.

Oat Hill	do	Middletown, Lake County (9 miles southeast).	E. J. Sittig, owner, 2146 Shattuck Avenue, Berkeley, Calif.; Murray Innes, 217 Kohl Building, San Francisco, Calif., lessee.	Cinnabar disseminated in sandstone of Franciscan group along fissure zones.	Extensive; many long tunnels.	New 50-ton Scott furnace; old furnaces dismantled.	After subtraction of 10,000 flasks estimated as from Aetna (see above), 131,312.	Underground workings mostly inaccessible, partly reopened in 1918.
Rutherford (Bella Union).	do	Oakville (2 miles west).	H. W. Gould, 608 Crocker Building, San Francisco, Calif.	Cinnabar disseminated and in stringers in serpentine.	Tunnels	One 4-foot by 56-foot rotary furnace; 12 Johnson-McKay retorts.	Probably not more than 1,500.	
Twin Peaks	do	Middletown (9 miles southeast).	B. A. and A. A. Wilson and L. D. Fay, Calistoga, Calif.	Cinnabar in veinlets and disseminated, forming irregular bodies in serpentine.	do	Two 900-pound D retorts; concentrating table.	Small; probably 500 to 1,000.	
Alpine (Esmeralda).	San Benito	Hernandez (6 miles east by road).	Alpine Quicksilver Mining Co., Hollister, Calif.	Cinnabar in veinlets and disseminated in serpentine, forming irregular bunches of ore.	700-foot tunnel, and irregular upper workings about 200 feet deep.	20-ton Scott furnace, 8 D retorts, 2 Johnson-McKay retorts.	418	No recent production
Aurora (Morning Star, Monterey).	do	Idria (5 miles southeast by road).	Esmeralda Quicksilver Mining Co., owner, 942 Phelan Building, San Francisco, Calif.; Sam Soyster, lessee, Idria, Calif.	Lenticular ore bodies of cinnabar in stringers and disseminated in serpentine.	Open cuts and about 500 feet of tunnels and raises.	50-ton rotary furnace.	Small; probably not more than 250.	Do.
Bradford	do	Tres Pinos (16 miles southeast).	H. R. Bradford, San Jose, Calif.	Cinnaber in serpentine.	Tunnels and 200-foot inclined shaft.	Probably none	None recorded	Idle.
Butts	do	Tres Pinos (21 miles south).	William Butts; Pine Rock, Calif.	Cinnabar as impregnation of sandstone of Franciscan group (?).	300-foot tunnel	2 D retorts	Very small; no record.	Do.
Cerro Bonito	do	Llanda (3 miles south).	Thomas Flint, Hollister, Calif.	Cinnabar disseminated in opalized serpentine.	Tunnels; inaccessible but reported to be fairly extensive.	25-ton Knox-Osborne coarse-ore furnace; dismantled.	About 800	Long idle.
Flint (Andy Johnson, Fourth of July, Boston, Clear Creek).	do	Hernandez (5 miles east by road).	do	Cinnabar disseminated and as stringers in serpentine.	Open cuts and probably about 1,000 feet of tunnels and drifts.	Furnace dismantled.	No record	Do.
Florence Mac	do	Hernandez (7 miles southeast by road).	Florence Mac Mining Co., Kings City, Calif.	Reported to be cinnabar in shale.	300 to 400 feet of tunnels.	12 Johnson-McKay retorts.	Small; no complete record.	Idle.
Hernandez (Los Picachos, Ramirez).	do	Hernandez	Hernandez Quicksilver Mining Co., Hernandez, Calif.	Cinnabar disseminated and in stringers in altered serpentine.	Shallow cuts and 3,000-foot tunnel.	4-ton fine ore furnace.	do	Do.

Quicksilver mines in the United States—Continued.

Mine.	County.	Post office.	Operator or owner, and address.	Character of deposit.	Workings.	Reduction equipment.	Production to end of 1918.	Remarks.
CALIFORNIA—con.							*Flasks.*	
New Idria	San Benito	Idria	New Idria Quicksilver Mining Co., 70 Kilby Street, Boston, Mass.; 608 Crocker Building, San Francisco, Calif.	In New Idria mine proper, cinnabar as veinlets and disseminations, forming large irregular, lenticular ore bodies in shale and sandstone of the Franciscan group. In San Carlos workings, cinnabar mainly as veinlets and impregnations in sandstone of Franciscan.	Very extensive; 10 tunnel levels to vertical depth of 1,060 feet in New Idria, with a number of long crosscut tunnels. In San Carlos chiefly open-cut work. In all, probably between 5 and 6 miles of horizontal workings.	2 80-ton coarse-ore furnaces; 60-ton Scott furnace; 5 rotary furnaces; 300-ton concentrating mill.	315,034	At present the most productive quicksilver mine in the Western Hemisphere, yielding from 10,000 to 11,000 flasks annually.
Wonder	do	Idria (1½ miles west).	Manuel Gonzales, 47 Grant Street, San Jose, Calif.	Cinnabar in stringers in sandstone of the Franciscan group.	Short tunnels; caved.	6 10-inch Johnson-McKay retorts.	119	Idle.
Buena Vista (Mahoney, Gould).	San Luis Obispo	Paso Robles (14 miles west).	Mary I. O'Toole, San Jose, Calif.	Cinnabar in crushed and sheared sandstone and shale of the Francisan group.	Cuts and tunnel	Probably none		Do.
Cambria (Bank)	do	Cambria (5 miles north, 13 by road).	Cambria Quicksilver Co., 1259 St. Andrews Place, Los Angeles, Calif.	Cinnabar and a little native quicksilver in altered serpentine.	Old; about 1,500 feet of tunnels and drifts. New or Red Hill about 3,000 feet north of old; about 2,000 feet of tunnels and drifts.	50-ton Scott furnace; D retort.	4,135	Do.
Capitola	do	Paso Robles (15 miles west).	F. M. Villegas et al., Klau, Calif.	Cinnabar in crushed and sheared sandstone and shale of the Franciscan group.	Tunnels	1,000-pound D retort.	24	No recent production.
Huasna (Deer Trail).	do	Huasna (7 miles east).	H. H. Carpenter et al., San Luis Obispo, Calif.	Cinnabar, probably in serpentine.	do	12 Johnson-McKay retorts.	70	Idle.
Keystone	do	San Simeon (16 miles east, by road).	Phelan Bros., Cambria, Calif.	Cinnabar in veinlets and disseminated in serpentine.	do	5-ton coarse-ore furnace; dismantled.	Small; probably less than 100.	Long idle; tunnels caved.

Klau (Karl, Sierra Morena, Sunderland, Santa Cruz).	....do........	Klau.............	Antone Luchessa et al., San Luis Obispo, Calif.	Cinnabar in veinlets and disseminated in crushed and sheared sandstone and shale of the Franciscan group.	Open cuts; inclined shaft, reported 800 feet deep; tunnels and extensive drifts.	60-ton Scott furnace, dismantled; 13 Johnson-McKay retorts; capacity 2½ tons.	Recorded, 12,662.	Idle.
La Libertad.......	....do........	Klau (3½ miles south).	....	Cinnabar in altered serpentine mass in crushed and sheared sandstone and shale of Franciscan group.	About 1,000 feet of tunnels and drifts.	12 Johnson-McKay retorts.	Small; probably less than 100.	Do.
Little Bonanza (Josephine, Alice & Modoc).	....do........	Klau (2½ miles south).	R. W. Putnam, agent, San Luis Obispo, Calif.	Cinnabar disseminated and in veinlets, forming lenticular bodies in serpentine.	Tunnels, drifts, and raises.	24 Johnson-McKay retorts.	Some production but no complete record.	Idle; one of oldest mines in State.
Oceanic...........	....do........	Cambria (5 miles east-northeast).	Murray Innes, 217 Kohl Building, San Francisco, Calif.	Fine-grained Miocene sandstone impregnated with cinnabar.	Open cut; about 3,000 feet of tunnels and 3,500 feet of drifts; depth about 600 feet, of which about 300 is below lowest tunnel.	2 50-ton Scott furnaces; 2 D retorts.	24,705...........	
Rinconada........	....do........	San Luis Obispo (9 miles east).	Therisa L. Bell, San Jose, Calif.	Reported to be in serpentine.	About 1,000 feet of tunnels.	Old, coarse-ore furnace; 20 Johnson-McKay retorts.	Small; no record.	
Acachuma (Red Rock).	Santa Barbara..	Los Olivos (12 miles east northeast).	Charles Wood and Dalton, Los Olivos, Calif.	Reported in serpentine and shale.	About 2,000 feet of tunnels.	12 Johnson-McKay retorts.	Small; probably not more than 100.	Idle.
Los Prietos.......	....do........	Santa Barbara (8 miles north; 40 miles by road).	F. M. Townsend, 912 Higgins Building; Los Angeles, Calif.	....do..............	Open cuts and tunnels.	....do..........	Small; probably less than 1,000.	Formerly a furnace and some early production, of which there is no complete record.
El Senador........	Santa Clara.....	San Jose (9 miles south).	New Almaden Co. (Inc.), 34 Pine Street, New York City.	Lenticular and irregular masses consisting of cinnabar veinlets and bunches in serpentine.	Shaft main tunnel or 260-foot level; inclined winze and levels at 400, 500, and 600 feet.	45-ton Herreshoff furnace with Cottrell treater; 90-ton Scott furnace.	Included with New Almaden.	About 4 miles northwest of old workings of New Almaden.
Enriquita........	....do........	San Jose (11 miles south).	....do...............	Probably in serpentine.	Tunnels extensive but not accessible,	None...........	About 11,000 prior to 1865; production included with New Almaden.	Long idle.
Hillsdale (San Juan Bautista, Chapman).	....do........	San Jose (2 miles southeast).	Elizabeth Kohrs, Hillsdale, Calif., via San Jose, R. F. D.	..........do........	Tunnels said to be 3,000 to 4,000 feet of workings.	2 12-inch Johnson-McKay retorts.	Small; no record.	Idle.

Quicksilver mines in the United States—Continued.

Mine.	County.	Post office.	Operator or owner, and address.	Character of deposit.	Workings.	Reduction equipment.	Production to end of 1918.	Remarks.
CALIFORNIA—con.							*Flasks.*	
New Almaden	Santa Clara	San Jose (12 miles south).	New Almaden Co. (Inc.), 34 Pine Street, New York City.	Large irregular masses and lenses composed of cinnabar in veinlets and bunches in serpentine.	Shafts and tunnels; workings extend over fully half a square mile and to a depth of 2,245 feet; the largest and deepest quicksilver mine in the Western Hemisphere.	Formerly 9 furnaces of various kinds; now mostly dismantled; washer for recovering quicksilver from material from under old furnaces.	1,043,095 (output for 1900 and 1901 not on record estimated at 9,000 and included in above).	Lower levels under water and mine practically idle; the oldest mine in California and one of the most productive quicksilver mines in the world.
New Guadalupe	do	Los Gatos (5 miles southeast).	New Guadalupe Mining Co., Motor Route A, Los Gatos, Calif.	Lenticular and irregular masses consisting of cinnabar in veinlets and bunches in serpentine.	Old shaft 625 feet with winze to 900 feet and extensive levels, in part under water; new or datum inclined shaft 700 feet deep; several hundred feet of drifts.	2 20-ton Davy coarse-ore furnaces; 2 30-ton Scott-Davy furnaces.	87,769	Old mine being reopened.
Silver Creek	do	San Jose (12 miles southeast by road).	A. R. Bradford et al., 770 East St. John Street, San Jose, Calif.	Reported to be in serpentine.	Probably tunnels	20-ton Scott furnace.	No record; probably 1,000 to 1,500 flasks.	Idle.
Brownlie	Solano	Vallejo (4 miles east-northeast).	John Brownlie estate, Vallejo, Calif.	Cinnabar in joints in much altered rhyolite tuff and perhaps some massive rhyolite.	Tunnels now accessible and open cut.	15-ton Scott furnace.	No record	Long idle.
Hastings	do	Vallejo (4½ miles east-northeast).	Hastings estate; C. W. Hunt, agent, Russ Building, San Francisco, Calif.	Cinnabar in joints in much altered rhyolite tuff.	About 1,500 feet of tunnels and drifts.	6-ton Neate furnace; 3 large D retorts.	Small; no complete record.	
St. Johns	do	Vallejo (6 miles northeast).	St. Johns Mines Co., Vallejo, Calif.	Cinnabar in Knoxville shale near small irregular intrusions of much altered igneous rock—apparently a quartz diorite porphyry.	400-foot shaft; tunnels and 8 levels.	25-ton Scott furnace; 2 20-ton Neate furnaces.	About 17,000	

Cloverdale	Sonoma	Cloverdale (12 miles east).	Western Mercury Co. (Inc.), Cloverdale, Calif.	Cinnabar in fractures in radiolarian chert of the Franciscan group.	Open cuts and tunnels.	30-ton modified Livermore furnace; rotary furnace (to be in operation in 1919; 500-pound D retort.	About 8,000	
Culver-Baer (Oakland).	do	The Geysers (1½ miles south).	Culver-Baer Mining Co., Cloverdale, Calif.	Cinnabar in stringers and disseminations in altered serpentine.	3,000 to 4,000 feet of tunnels and drifts.	14-ton Knox-Osborne coarse-ore furnace; 24-ton Scott furnace.	About 9,500	
Eureka (Flagstaff).	do	The Geysers (5 miles southeast).	Eureka Quicksilver Mining Co., 1421 High Street, Alameda, Calif.	Reported to be cinnabar, metacinnabar, and native quicksilver on contact between serpentine and sandstone of Franciscan group.	About 1,500 feet of tunnels.	10-ton Livermore(?) furnace.	Small; probably less than 100.	
Great Eastern	do	Guerneville (3 miles northeast).	Great Eastern Quicksilver Mining Co., 450 Mountain Avenue, Piedmont, Oakland, Calif.	Cinnabar in stringers and disseminations forming irregular ore bodies in serpentine.	Tunnels, with shaft and winzes to 620 feet.	2 20-ton Scott furnaces; 21,000-pound D retorts.	About 43,500	Shaft levels under water, production includes adjoining Mount Jackson.
Rattlesnake	do	The Geysers (3 miles southeast).	G. W. Wheeler and F. G. Kiessig, owners, 517 San Pedro Street, Los Angeles, Calif.; R. A. Sallee, lessee, Pine Flat, Calif.; Owen Slevin, sublessee, Pine Flat, Calif.	Native quicksilver in zones of shearing in sandstone and shale of Franciscan group.	About 450 feet of tunnels.	3 Johnson-McKay retorts.	Small; probably less than 100.	
Socrates	do	Pine Flat (2½ miles north).	Socrates Consolidated Mining Co., 68 Post Street, San Francisco, Calif.	Native quicksilver and cinnabar in sandstone of Franciscan group, near serpentine.	Tunnels and drifts.	35-ton Scott furnace.	About 4,500	
Phoenix (Summit, Grayson, Orestimba, Hayward).	Stanislaus	Livermore (39 miles by road south).	Alvinza Hayward estate and Emma Rose, owners; E. S. McCurdy, manager, 576 Mills Building, San Francisco, Calif.	Ore reported as cinnabar in sandstone and serpentine.	Tunnels	50-ton Scott furnace.	About 200	Idle.
Altoona	Trinity	Carrville (15 miles northeast).	Altoona Quicksilver Mining Co., 333 Kearny Street, San Francisco, Calif.	Ore reported to be in serpentine and porphyry.	Tunnel and 600-foot shaft with levels.	30-ton Knox-Osborne fine-ore furnace with retorts.	29,350	Idle; small production in 1918 from dump.

Quicksilver mines in the United States—Continued.

Mine.	County.	Post office.	Operator or owner, and address.	Character of deposit.	Workings.	Reduction equipment.	Production to end of 1918.	Remarks.
CALIFORNIA—con.							*Flasks.*	
Integral	Trinity	Carrville (15 miles northeast).	Integral Quicksilver Mining Co., 91 Park Row, New York City.	Ore reported to be in serpentine and porphyry.	2,800-foot tunnel, 180-foot shaft and 5 levels.	24-ton Knox-Osborne furnace.	Small; no record.	Idle.
January (Harrison, Ruby, New England).	Yolo	Rumsey (3½ miles south-southwest).	M. W. and Madge Harrison, owners, Georgetown, Calif.; January Jones and General Mines Co., lessees, Stanford Hotel, San Francisco, Calif., and Reno, Nev.	Cinnabar disseminated and in veinlets in serpentine.	Tunnels	100-ton concentrating mill; 75-ton rotary furnace in 1919; 2 D retorts.	121	Production from development only.
Reed (California)	do	Rumsey (3 miles south-southwest).	A. H. Breed, Oakland Bank Builidng, Oakland, Calif.	Metacinnabar and cinnabar disseminated and as stringers in serpentine.	Open cuts and tunnels.	Furnace dismantled.	5,700	Long idle.
IDAHO.								
Fern	Valley	Yellowpine	Fern Quicksilver Mining Co., 906 Bannock Street, Boise, Idaho.	Cinnabar in stock work of irregular veinlets in limestone.	Tunnel	12 Johnson-McKay retorts.	22	Production began in 1918.
Monumental (Pringle Smith).	do	do	Pringle Smith, owner, Warren, Idaho; Monumental Mercury Mines Co., lessee, Boise, Idaho.	do	Tunnels	72 14-pound retorts.	None	Developing.
NEVADA.								
Ivanhoe	Elko	Elko (50 miles northwest).	Ivanhoe Cinnabar Co., 201 Newhouse Building, Salt Lake City, Utah.	Cinnabar dessiminated in altered rhyolite.	Pits and tunnels	6 D retorts	20	Idle.
Lost Steers (Pepper and Keough).	Mineral	Mina (12 miles east).	W. T. Miles, lessee, Mina, Nev.	Cinnabar disseminated through limestone.	Shallow cuts	1 D retort	344	(No return for 1918.)
Bugg & Drew (Red Devils; Farnham and Drew).	do	Mina (14 miles east).	Bugg & Drew, owners, Mina, Nev.; Mina Quicksilver Co., Reno, Nev., lessee.	Cinnabar and oxidized compounds of lead as lenticular masses in shale.	Inclined shaft 150 feet and 3 levels.	2 D retorts; 12 Johnson-McKay retorts.	724	
Red Rose	do	Mount Montgomery (5 miles south).	Mount Montgomery Mercury Co., Belleville, Nev.	Cinnabar in irregular fissures in much altered rhyolite.	Tunnels	2 500-pound D retorts.	138	

Mercury	Nye	Ione (1 mile southeast).	Mercury Mining Co., 1022 Crocker Building, San Francisco, Calif.	Irregular bodies in shattered limestone and in agglomerate.	Open pits and "glory holes," tunnels.	25-ton Scott furnace.	5,793	
Nevada Cinnabar (Shoshone).	do	Ione (2 miles southeast).	Nevada Cinnabar Co., Kearns Building, Salt Lake City Utah.	Cinnabar disseminated and in fractures in altered rhyolite.	Open cut	50-ton Scott furnace; 2 D retorts.	3,907	
Dixie	Pershing	Fitting					About 100	Idle.
Dolbear	do	Lovelock (22 miles southeast).	Southern Pacific Co., San Francisco, Calif.	Cinnabar disseminated through shattered limestone.	Tunnels	Retorts dismantled.	181	Do.
Goldbanks	do	Winnemucca (30 miles south).	Goldbanks Quicksilver Co., Winnemucca, Nev.	Cinnabar disseminated in altered rhyolite.	Open cut; shafts and drifts to 200 feet.	50-ton Herreshoff furnace.	1,461	Developing.
Lovelock	do	Lovelock (22 miles southeast).	Lovelock Quicksilver Mining Co., Lovelock, Nev.	Cinnabar dispersed through shattered limestone.	Open cuts and tunnels.	12 12-inch Johnson-McKay retorts.	About 150	Idle.
Ruby	do	Imlay (10 miles southwest).	Ruby Mining Co., Winnemucca, Nev.	Veinlets in fractured limestone.	Tunnels	Retorts	About 500	Do.
OREGON.								
Elkhead	Douglas	Elkhead	Elkhead Quicksilver Co., Salem, Oreg.	Cinnabar disseminated in altered andesite tuff.	Tunnels and open stope.	20-ton Scott furnace.	No record	Idle.
Little Jean	Jackson	Gold Hill (18 miles north-northwest)	Dr. W. P. Chisholm, Gold Hill, Oreg.	Cinnabar and native quicksilver in crushed sandstone and shale.	About 300 feet of tunnels.	12 Johnson-McKay retorts.	Probably not more than 20.	Do.
War Eagle (Rainier, Utah).	do	Gold Hill (about 18 miles north-northwest).	War Eagle Mining Co., Beagle, Oreg.	Cinnabar in zones of crushing in granite porphyry.	2 short tunnels and about 200 feet of drifts.	do	About 300	
Black Butte	Lane	Blackbutte, Oreg.	Black Butte Mercury Mines Co., Blackbutte, Oreg.	Cinnabar in fissure zone in andesite and andesite tuff.	Tunnels and drifts to 900 feet below outcrop.	36-ton Scott furnace, 2 Johnson-McKay retorts: 40-ton flotation mill.	About 2,000	
TEXAS.								
Big Bend	Brewster	Study Butte	Study Butte Mining Co., Study Butte, Tex.	Cinnabar in fissures near contact of porphyry and shales of Eagle Ford formation.	Shaft and shallow levels above water level.	50-ton Scott furnace.	About 5,000	
Chisos	do	Terlingua	The Chisos Mining Co., 304 Sharpless Building, 565 West Washington Street, Chicago, Ill.	Cinnabar in and near fissure zone in Cretaceous limestone and shale	3 shafts and extensive levels to depth of 750 feet and for a distance of about 2,500 feet along fissure zone.	20-ton Scott furnace; rotary furnace.	About 45,000	

Quicksilver mines in the United States—Continued.

Mine.	County.	Post office.	Operator or owner, and address.	Character of deposit.	Workings.	Reduction equipment.	Production to end of 1918.	Remarks.
TEXAS—contd.							*Flasks.*	
Colquit-Tignor (X. L. C. R.).	Brewster	Terlingua (3 miles west).	....	Cinnabar in fissure zone in Edwards limestone.	Shaft about 150 feet and short levels.	10-ton Scott furnace.	Small; probably not more than 300.	Idle.
Ellis	do	McKinney Springs (6 miles south-southwest).	W. D. Burcham, McKinney Springs, Tex.	Cinnabar in fissure zone in beds of Eagle Ford (Upper Cretaceous) age.	Shaft and levels to depth of 150 feet.	3 inclined retorts, capacity 4 tons.	About 700	
Mariposa	do	Terlingua (5 miles west).	Mariposa Mining Co., 1135 Real Estate Trust Building, Philadelphia, Pa.	Cinnabar along fissure zones in Edwards (Lower Cretaceous) limestone.	Open cuts, shafts, tunnels, and extensive shallow levels.	50-ton Scott furnace, leased from Terlingua Mining Co.; 2 10-ton Scott furnaces.	28,045	
Texas-Almaden (Dallas).	do	Study Butte	Texas-Almaden Mining Co., owner, Dallas, Tex.; W. D. Burcham et al., lessees, Study Butte, Tex.	Cinnabar in beds of Eagle Ford age at contact with porphyry.	Shaft and levels, under water in 1918.	25-ton Scott furnace.	No record; probably not more than 500.	

RECENT PUBLICATIONS ON QUICKSILVER IN NORTH AMERICA.

Compiled by **Isabel P. Evans.**

These references for the year 1918 are supplemental to the bibliography of quicksilver in North America published with the report on quicksilver in 1917. The annotations link the references to the subject index of the bibliography, to which they can be added later.

Alaska and Northwest Mining Journal. Most promising deposit of mercury at Hardy Mountain, near Kamloops Lake, British Columbia: Vol. 12, p. 151, July, 1918.

An English company installed a plant on the west side of Copper Creek, at Hardy Mountain, near Kamloops Lake, British Columbia, some twenty years ago and extracted 7,000 pounds of mercury.

Bell, R. N. Quicksilver and antimony discoveries in central Idaho: Idaho Min. Dept. Bull. 1, [11 pp.], July 25, Boise, 1918.

These discoveries were made along the eastern border of the Yellow Pine mining district, formerly in Idaho County, but now in Valley County. The quicksilver occurs in a limestone or quartzite, probably Cambrian or pre-Cambrian in age.

——— Nineteenth annual report of the mining industry of Idaho, for the year 1917: War metals [quicksilver], pp. 95–96, 1918.

The Fern Quicksilver Mining Co., in Idaho County, about 18 miles southeast of Yellow Pine post office, has discovered a mercury deposit in the form of cinnabar, which it is believed will average 20 pounds of quicksilver per ton across a width of 20 feet.

Boletín Minero, Mexico. Cuotas de exportación de minerales y metales, para los meses de febrero, de marzo, y de abril de 1918 (mercurio): Vol. 5, pp. 387, 389, 391, March and April, 1918.

Gives quotations of exportation of mercury from Mexico during the months of February, March, and April, 1918.

Bradley, W. W. Quicksilver resources of California, with a section on metallurgy and ore dressing: California State Min. Bur. Bull. 78, 389 pp., 77 photos, 42 pls. (incl. maps), May, 1918.

Gives the general geology of the deposits, the theories of ore deposition, the principal mercury minerals, the districts in California in which they are found, and discusses metallurgical methods. Contains a bibliography on quicksilver.

——— California mineral production for 1917 [quicksilver]: California State Min. Bur. Bull. 83, pp. 43–47, 1918.

Contains a table of monthly average quicksilver quotations at San Francisco from January, 1914, to February, 1918, inclusive. Gives its production by counties in 1917 and the total quicksilver production of California from 1850 to 1884.

British Columbia Bureau of Mines. Annual report of the minister of mines for the year ending 31st December, 1917, being an account of mining operations for gold, coal, etc., in the province of British Columbia [cinnabar]: p. F219, 1918. Victoria, B. C.

Cinnabar has been found in the vicinity of Copper Mountain, 25 miles almost due west from the junction of Gun Creek with Bridge River, in the Lillooet mining division, B. C.

Brooks, A. H., and others. Mineral resources of Alaska; report on progress of investigations in 1916 [quicksilver]: U. S. Geol. Survey Bull. 662, pp. 25, 60, 270–272, 274, 446, 1918.

There was some mining of quicksilver ores in the lower Kuskokwim region, but no details have been learned. Cinnabar is present on Fresh River in the Council district, on Seward Peninsula. Cinnabar is plentiful on Olive Creek.

Chemical and Metallurgical Engineering. Quicksilver at New Idria, Calif.: Vol. 19, pp. 237–240, 5 figs., Sept. 1, 1918.

The furnace at the New Idria in San Benito County, Calif., is now treating ore containing but 6½ pounds of mercury per ton. Such lean ore offers a good field for modern concentration methods. Describes the Scott furnace. Expected consumption of quicksilver in 1918 estimated at 36,166 flasks.

Conferences on the quicksilver industry. See United States Tariff Commission.

Duschak, L. H., and Schuette, C. N. Condensing quicksilver from furnace gases: Min. and Sci. Press, vol. 117, pp. 315–323, 5 figs., Sept. 7, 1918.

Describes the apparatus used by quicksilver mining companies in the condensation of mercury from furnace gases. Decides that the most effective way of recovering all the mercury in suspension would be through the use of electric precipitation.

Emmons, W. H. The principles of economic geology [mercury, quicksilver, and cinnabar], 1st ed., pp. 149, 261–263, 499–502, New York and London, 1918.

Describes the occurrence of mercury at Steamboat Springs, Nev., and at Sulphur Bank, Calif. Deposits of cinnabar occur in New Mexico, Nevada, Utah, and Oregon. Production was greatly increased in 1915.

——— Exploration of metalliferous deposits [mercury]: Am. Inst. Min. Eng. Trans., vol. 58, p. 241, 1918.

"There is indisputable evidence that secondary mercury minerals result from processes of sulphide enrichment, but these are small in amount because chlorides in general are not abundant in waters of deposits of mercury ores. Mercury must be placed with metals that are not migratory."

Engineering and Mining Journal. Quicksilver statistics in 1917: Vol. 105, pp. 51–52, Jan. 12, 1918.

Gives a table of the average monthly price of quicksilver for the year 1917. The domestic production of quicksilver in 1917 was about 20 per cent greater than that of 1916.

——— Effect of mercuric sulphate in flotation: Vol. 105, p. 916, May 18, 1918.

"The effect of mercuric sulphate is to lower the extraction without any very great change in the lead content of the concentrates."

——— Position of the quicksilver producers in California: Vol. 106, pp. 439–442, Sept. 7, 1918.

The position taken by the producers was that an adequate tariff on quicksilver importation is vital if domestic production is to be maintained. Very low-grade ores and increase in operating costs make the future of quicksilver mining uncertain.

Gould, H. W. The position of the quicksilver producers in California (abstract): Eng. and Min. Jour., vol. 106, pp. 439–442, Sept. 7, 1918.

This report is practically the answers made by Mr. Gould to questions and important suggestions from those present at the conference in San Francisco before the United States Tariff Commission.

Hostetter, J. C., and Sosman, R. B. A silica glass mercury still: Washington Acad. Sci. Jour., vol. 8, pp. 11-15, 1 fig., Jan. 4, 1918.

The mercury still described avoids one undesirable feature common to all vacuum mercury stills, namely, that when slightly overheated they collapse under the pressure of the atmosphere. Gives suggestions for the preliminary treatment of the mercury.

Innes, Murray. Quicksilver in California: Eng. and Min. Jour., vol. 105, p. 52, Jan. 12, 1918.

The writer states that few of the quicksilver mines in California are operating at a profit even at present prices and thinks that in future California producers can no longer compete with the European output, produced at small cost and skillfully marketed by the Rothschilds.

——— Metallurgy of quicksilver: Eng. and Min. Jour., vol. 105, pp. 110–111, Jan. 12, 1918.

Considers inadequate sampling responsible for many failures. Overestimation of the ore roasted and its assay value and insufficient allowance for moisture also play a part.

——— Quicksilver in Europe and its relation to the future of the industry in the United States: Mineral Industry, vol. 26, pp. 609–615, 1918.

Describes the quicksilver ore bodies of Spain, Italy, and Austria and their cost of production, which should prove to anyone familiar with the quicksilver industry in the United States that it will be impossible for our quicksilver producers to compete with European producers.

McLeish, John. Annual report on the mineral production of Canada during the calendar year 1916 [mercury], p. 123, Canada Dept. Mines, Mines Branch, 1918.

There has been no production of mercury in Canada since 1897. The small production reported in 1895 and 1897 was derived from deposits at the western end of Kamloops Lake, British Columbia. Elsewhere in Canada mercury has been reported in the Cobalt district; near Field, British Columbia; and at the eastern entrance to Sechart Channel, Barclay Sound, Vancouver Island.

Metallurgical and Chemical Engineering. Improved quartz mercury-vapor lamp for ultra-violet light: Vol. 18, pp. 43-44, fig., Jan. 1, 1918.

Illustrates and describes an improved form of quartz mercury-vapor lamp which produces an ultra-violet component several times stronger than that yielded by other forms of quartz mercury-vapor lamps.

Mineral Industry. Quicksilver: Vol. 26, pp. 602-609, 1918.

Gives production of quicksilver in 1917 in California, Texas, Nevada, Arizona, Oregon, and Washington. Metallurgy of quicksilver is at present the sole work of the Berkeley, Calif., station of the United States Bureau of Mines. States that the stack and fume losses of a Scott furnace, when properly operated, are practically nil.

Mining and Scientific Press. Metallurgy of mercury: Vol. 116, p. 478, Apr. 6, 1918.

Describes the operation and cost of operating the Scott furnace. Quotes H. W. Gould, of New Idria, that the rotary furnace has great possibilities.

——— The production of quicksilver and tungsten (as discussed before the United States Tariff Commission at San Francisco): Vol. 117, pp. 5-8, 2 figs. (maps), July 6, 1918.

Summarizes the output and prices of quicksilver in the United States from 1913 to 1917. Gives map of the United States showing situation of quicksilver deposits.

New International Yearbook. Quicksilver, p. 566, New York, 1918.

The demand for quicksilver has been stimulated by its large consumption in war supplies. Gives the domestic output of quicksilver in 1917, the average San Francisco market price for the year, and the exports for the first 10 months of 1917.

Paredes, T., and Cervantes, E. A. Tabla que muestra las especies minerales de importancia industrial, con el por ciento de metal contenido y sus principales propiedades [mercurio (azogue)]: Boletín Minero, Mexico, vol. 5, p. 354, March and April, 1918.

Gives chemical analyses of mercury under the forms of metacinnabarite, tiemannite, onofrite, and cinnabar.

Park, James. A text-book of mining geology [quicksilver], pp. 207, 288-289, London, 1918.

The quicksilver mines at Sulphur Bank, Calif., furnish important evidence in relation to the genesis of ore deposits. The geological features are almost identical with those at Ohaeawai, New Zealand. "Cinnabar deposits have been formed by solfataric action in the waning phases of volcanic activity." (p. 288.) The United States ranks seventh in the world's annual production of quicksilver.

Salt Lake Mining Review. California metal production in 1917 [quicksilver]: Vol. 19, p. 22, Jan. 30, 1918.

Estimates production and cost of quicksilver in California in 1917.

——— Outlook for quicksilver: Vol. 20, pp. 44-45, July 20, 1918.

Compares costs of production in Spain and America, gives the output in 1917 of California, Texas, Nevada, and of Arizona and Oregon combined. The uncertainty of war demands has prevented extensive financing of an industry in which there has been little profit for decades.

Schrader, F. C. Quicksilver deposits of the Phoenix Mountains, Ariz.: U. S. Geol. Survey Bull. 690, pp. 95-109, 4 figs. (incl. maps), 1918. Abstract in Science, new ser., vol. 48, p. 463, Nov. 8, 1918.

Gives the history of the quicksilver industry in Arizona, the geologic occurrence, describes the mines and prospects, and states the probable origin of the deposits in the Phoenix Mountains.

Sharwood, W. J. Loss of quicksilver in gold mills: Min. and Sci. Press, vol. 116, pp. 483-485, Apr. 6, 1918.

Gives a table of the loss of quicksilver in stamp mills in Alaska, California, Colorado, Montana, South Dakota, Nova Scotia, and Mexico; also in Venezuela, South Africa, Asia, and Australasia.

Smith, H. G. Loss of quicksilver: Min. and Sci. Press, vol. 117, p. 514, Oct. 19, 1918.

Gives data on the loss of quicksilver in operation of the plant of the La Luz and Los Angeles Mining Co. of Nicaragua, Central America.

Spurr, J. E. War minerals [mercury]: Econ. Geology, vol. 13, p. 508, November, 1918.

States that the United States produces all the mercury it requires and has some left over to ship to our allies. "Mining geologists should keep this in mind and do what they can to increase the production when the matter is brought before them."

Udden, J. A. Fossil ice crystals [a guide to prospecting for quicksilver in the Terlingua district, Tex.]: Texas Univ. Bull. 1821, 8 pp., 10 pls., Apr. 10, 1918.

The layer which carries ice-crystal markings has a definite relation to the seams of bentonite and enabled the author not only to locate the right horizon but also a horizon in the heavy Comanchean limestone, which is water bearing and must be avoided.

——— The anticlinal theory as applied to some quicksilver deposits: Texas Univ. Bull. 1822, 30 pp., 16 figs., Apr. 15, 1918.

"In general it can be said that the greatest amount of [quicksilver] ore has so far been found in fissured and faulted parts of anticlines, domes, and arrested monoclines." (p. 30.)

United States Tariff Commission. Conferences on the quicksilver industry of the United States [typewritten], 199 pp., San Francisco, Calif., 1918.

Stenographic report of the statements and discussions at the conferences on the quicksilver industry of the United States, made to the United States Tariff Commission, at San Francisco.

GOLD, SILVER, COPPER, AND LEAD IN SOUTH DAKOTA.

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

The total value of the gold, silver, copper, and lead produced at mines in South Dakota in 1918 was $6,744,338, a decrease of $782,567 from the value in 1917. The output of gold was 317,598.18 fine ounces, valued at $6,565,337, more than 97 per cent of the total value. The decrease in the output of gold for the year was 38,646.59 fine ounces in quantity and $798,896 in value. The production of silver decreased in quantity from 186,765 fine ounces to 159,202 fine ounces, but the value increased from $153,894 to $159,202. The smelting ore and concentrates shipped from South Dakota carried 64,806 pounds of copper and 53,408 pounds of lead. The output of placer gold was 20.85 fine ounces. There were 22 producing mines, of which 16 were deep and 6 were placer, a decrease of 7 deep mines and 1 placer mine, as compared with 1917.

The total quantity of ore mined and treated in 1918 was 1,782,563 short tons, averaging in recovered gold 0.1782 ounce or $3.68 a ton, as compared with 1,868,310 short tons, averaging $3.94 a ton in 1917. The mills of the State treated 1,781,362 tons of ore, which yielded as bullion $6,562,343 in gold and 153,781 fine ounces of silver, valued at $153,781, an average recovery per ton of $3.68 in gold and 0.086 ounce in silver, as compared with $3.94 in gold and 0.10 ounce in silver in 1917.

Gold and silver bullion produced at mills in South Dakota in 1918.

Process.	Ore treated.	Gold in bullion.	Silver in bullion.
	Short tons.	*Fine ounces.*	*Fine ounces.*
Amalgamation	1,628,630	202,219.02	55,932
Cyanidation	[a] 1,718,541	115,234.34	97,849
	....	317,453.36	153,781

[a] Includes 1,565,809 tons of tailings from the ore amalgamated.

In 1918 the mines in South Dakota consumed 12,252 pounds of quicksilver and 370,218 pounds of sodium cyanide, equivalent to 1 pound of quicksilver for every 16.50 ounces of gold or every 132 tons of ore treated, and 0.22 pound of sodium cyanide for every ton of ore or tailings treated, and 0.31 ounce of gold for every pound of cyanide used.

Mine production of gold, silver, copper, and lead in South Dakota in 1917 and 1918.

Year.	Number of mines producing.	Ore.	Gold.[a]		Silver.[a]	
			Quantity.	Value.	Quantity.	Value.
		Short tons.	*Fine ounces.*		*Fine ounces.*	
1917	30	1,868,310	356,244.77	$7,364,233	186,765	$153,894
1918	22	1,782,563	317,598.18	6,565,337	159,202	159,202
Increase or decrease	−8	−85,747	−38,646.59	−798,896	−27,563	+5,308

Year.	Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
1917	10,707	2,923	68,081	5,855	$7,526,905
1918	64,806	16,007	53,408	3,792	6,744,338
Increase or decrease	+54,099	+13,084	−14,673	−2,063	−782,567

[a] Includes placer production.

Mine production of gold and silver in South Dakota, 1876–1918.[a]

Period.	Gold.	Silver.		Total value (commercial).
		Quantity.	Commercial value.	
		Fine ounces.		
1876–1880	$11,255,843	80,292	$92,452	$11,348,295
1881–1890	30,800,000	1,472,580	1,515,224	32,315,224
1891–1900	48,005,555	1,729,873	1,155,691	49,161,246
1901–1910	65,242,196	1,790,365	1,013,349	66,255,545
1911	7,439,874	203,755	107,990	7,547,864
1912	7,891,370	206,460	126,973	8,018,343
1913	7,319,294	172,702	104,312	7,423,606
1914	7,333,508	176,642	97,683	7,431,191
1915	7,406,305	199,864	101,331	7,507,636
1916	7,460,644	215,205	141,605	7,602,249
1917	7,364,233	186,765	153,894	7,518,127
1918	6,565,337	159,202	159,202	6,724,539
	214,084,159	6,593,705	4,769,706	218,853,865

[a] For yearly output and authority for each, see U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 240, 1914.

Mine production of South Dakota in 1918, by classes of ore.

Source.	Number of mines.	Ore.	Gold.	Silver.	Copper.	Lead.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Deep mines:						
Siliceous	11	1,781,569	317,571.87	156,294		
Lead ore	2	357	3.91	2,652		53,408
Copper ore	3	637	1.55	256	64,806	
	16	1,782,563	317,577.33	159,202	64,806	53,408
Placer mines	6		20.85			
	22	1,782,563	317,598.18	159,202	64,806	53,408

MINING INDUSTRY.

Shortage of labor in 1918 curtailed development and mining operations at the Homestake mine. The Homestake mills were operated at full capacity up to October 27 and at 71 per cent of full capacity for the remainder of the year. The Golden Reward mill and mines were operated for the first three months at reduced capacity and then ceased operations. The Trojan and Mogul mills were operated the entire year. The Bismark mill was operated a few months.

In Custer County the Spokane mill, near Keystone, was completed and put into operation.

In Pennington County the Maloney Blue Lead mine was operated a part of the year, producing the greatest quantity of copper produced in the Black Hills since 1909.

The placer gold produced in South Dakota in 1918 was less than 50 per cent of that produced in 1917.

REVIEW BY COUNTIES.

CUSTER COUNTY.

A 100-ton concentrating plant was completed at the Spokane mine, between Custer and Keystone. Several cars of lead concentrates were shipped to Denver during the second half of the year.

LAWRENCE COUNTY.[a]

Mine production of gold, silver, copper, and lead in Lawrence County, S. Dak., 1904–1918.

Year.	Number of mines producing.	Ore.	Gold.[b]	Silver.[b]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	44	1,801,524	$7,346,986	161,216	....	....	$7,439,282
1905	19	1,826,177	6,955,690	182,597	....	....	7,065,979
1906	27	1,771,377	6,816,196	150,537	....	22,719	6,918,351
1907	22	1,470,154	4,134,667	93,830	....	....	4,196,595
1908	17	1,927,844	7,650,523	248,686	....	23,046	7,783,295
1909	17	1,699,200	6,561,628	191,044	3,977	1,512	6,661,553
1910	19	1,522,986	5,380,795	118,716	....	14,136	5,445,523
1911	16	1,940,719	7,408,356	203,350	....	64,311	7,519,025
1912	19	1,901,310	7,875,401	206,356	....	22,845	8,003,338
1913	20	1,899,162	7,317,320	172,688	290	10,205	7,422,117
1914	21	2,019,016	7,331,638	176,585	....	2,766	7,429,397
1915	25	1,889,970	7,405,552	199,797	....	....	7,506,849
1916	29	1,870,572	7,455,136	215,127	....	35,406	7,599,127
1917	24	1,868,143	7,360,266	186,436	736	60,905	7,519,328
1918	13	1,781,661	6,564,850	158,108	2,996	11,536	6,724,517
Increase or decrease, 1918.	−11	−86,482	−795,416	−28,328	+2,260	−49,369	−794,811

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[a] For information on the geology of this county see Irving, J. D., Ore deposits of the northern Black Hills: U. S. Geol. Survey Bull. 225, pp. 123–140, 1904. Irving, J. D., and Emmons, S. F., Economic resources of northern Black Hills: U. S. Geol. Survey Prof. Paper 26, pp. 53–212, 1904.

[b] Includes both placer and deep mines.

The following table shows the total ore milled, the value of the product, and the dividends paid from 1875 to 1918 by the companies now consolidated in the Homestake Mining Co. The production prior to 1916 is that reported by Blackstone.[1]

Production of Homestake mine, 1875–1918.

	Ore milled.	Value of product.	Value per ton.	Dividends.
	Short tons.			
Homestake Mining Co., to May 31, 1900		$31,204,685.28		$8,668,750.00
Highland Mining Co., to May 31, 1900		13,359,398.95		3,834,717.69
Caledonia Gold Mining Co., to May 31, 1900		2,341,130.92		192,000.00
Deadwood-Terra Mining Co., to May 31, 1900		9,001,002.61		1,350,000.00
Deadwood Mining Co., to May 31, 1900		834,192.28		275,000.00
Father de Smet Mining Co., to May 31, 1900		3,421,199.01		1,125,000.00
Gopher Mining Co., to May 31, 1900		71,140.41		
Clara Consolidated Mining Co., to May 31, 1900		13,590.56		
Total to June 1, 1900		60,246,340.02		15,445,467.69
Homestake Mining Co.:				
June 1, 1900, to June 1, 1901		3,639,232.08		1,260,000.00
June 1, 1901, to June 1, 1902		4,303,977.57		1,260,000.00
June 1, 1902, to June 1, 1903		4,526,942.04		819,000.00
June 1, 1903, to June 1, 1904		4,800,558.48		655,200.00
June 1, 1904, to June 1, 1905		5,221,089.30		819,000.00
June 1, 1905, to June 1, 1906		5,100,445.49		1,310,400 00
June 1, 1906, to June 1, 1907		4,541,096.07		1,201,200.00
June 1, 1907, to June 1, 1908		4,717,746.20		546,000.00
June 1, 1908, to June 1, 1909		5,725,046.67		1,365,000.00
June 1, 1909, to June 1, 1910	1,237,381	4,498,751.11	$3.6357	982,800.00
June 1, 1910, to June 1, 1911	1,468,263	5,251,453.75	3.5766	1,310,400.00
June 1, 1911, to Dec. 31, 1911	888,057	3,661,151.60	4.1205	764,400.00
Calendar year 1912	1,528,923	6,600,953.12	4.3174	1,310,400.00
Calendar year 1913	1,540,961	6,186,651.78	4.0148	2,146,224.60
Calendar year 1914	1,587,774	6,160,160.59	3.8798	2,210,208.00
Calendar year 1915	1,573,822	6,428,786.56	4.0848	2,210,208.00
Calendar year 1916	1,600,220	6,531,003.34	4.0813	2,210,208.00
Calendar year 1917	1,677,623	6,619,573.94	3.9458	1,959,048.00
Calendar year 1918	1,628,630	5,916,890.31	3.6330	1,506,960.00
Grand total		160,677,849.97		41,292,124.29

The annual report of the Homestake Mining Co. (dated Dec. 31, 1918) says:

> Shortage of labor curtailed operations at the Homestake mine during the year just passed, but the situation is now improving and a return to normal conditions may be exepected at an early date.
>
> Wolframite ore sufficient to keep the concentrating plant running continuously at full capacity has been mined during the year. There remains in the mine a considerable tonnage of this ore of fair grade for concentrating.
>
> No new construction work of magnitude was undertaken. Work in progress at the beginning of the year was carried on with the available labor.
>
> A coal storage bin having a capacity of 7,000 tons was built.
>
> One fan unit of the mine ventilating system was erected and put in operation and the second unit is being installed.
>
> A 3,000 cubic foot steam-driven compressor previously purchased has been changed to electric drive and installed at the B. & M. shaft and is now in operation.
>
> The Old Brig and Golden Gate hoists have also been changed from steam to electric power.

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[1] Blackstone, Richard, A history of the Homestake mine, S. Dak.: Min and Eng. World, July 15, 1916, pp. 99–102; South Dakota School of Mines Pahasapa Quart., June, 1916, pp. 16–30.

Both No. 1 and No. 2 hydroelectric power plants have been in operation throughout the year.

Owing to excessive cost and scarcity of supplies and particularly to shortage of labor, prospecting and development work in the mine on the scale heretofore in practice was cut down, although not entirely discontinued. The mine engineer reports 3,661 feet of development drifts, 1,820 feet of prospecting drifts, and 1,873 feet of development raises during the year. No shaft sinking was done.

There are 1,716,418 tons of ore broken down and remaining in the stopes.

The mine and surface plants are in good condition with enough ore developed for many years' profitable operation.

In addition to gold and silver, $167,468 was obtained from the sale of tungsten ores by the Homestake Mining Co.

The Deadwood Zinc & Lead Co. built a 50-ton concentration mill and made a test run of eight days.

In the Bald Mountain area and the Portland district the Golden Reward group of mines and the cyanidation mill at Deadwood, at reduced capacity, were in operation only during the first quarter of 1918.

The Trojan mill was operated the entire year, treating a small quantity of custom ore in addition to the ore from its own property.

The Mogul cyanidation mill, at Terry, was operated the entire year on custom ore shipped from the mines of the Ofer Co.

Other producing mines were the Elk Mountain, Silver Plume, and Two Johns.

In the Bear Butte district small shipments of lead ore were made from the New Silver Queen mine.

In the Custer Peak district development work was continued by the Custer Peak Milling & Ore Co. Shipments of silver-copper ore to the smelter began in August.

Activity in the Carbonate district consisted of work on a drainage tunnel begun in October by the Titanic Gold Mining & Milling Co. It is intended to drain the lower workings of the old Iron Hill mine.

In the Maitland district shipments were made from the Republic mine to the Trojan mill.

In the Yellow Creek area the Bismark mill was operated for a few months by a lessee, tungsten as well as gold being recovered from the ores treated.

In the Rawlings district, near Tinton, a small quantity of placer gold was produced from several placers, most of them in Bear Gulch and Potato Creek.

PENNINGTON COUNTY.

Mine production of gold, silver, copper, and lead in Pennington County, S. Dak., 1904–1918.

Year.	Number of mines producing.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	16	1,511	$10,500	274	....	....	$10,657
1905	8	11,218	33,096	149	....	....	33,186
1906	6	9,281	24,586	335	....	....	24,810
1907	7	969	3,190	62	....	....	3,231
1908	8	1,235	5,320	72	....	....	5,358
1909	13	4,481	14,897	3,208	114,408	....	31,438
1910	7	943	21,462	84	....	....	21,508
1911	16	5,408	31,209	401	....	....	31,422
1912	16	341	14,782	101	....	....	14,844
1913	5	....	1,780	13	....	....	1,788
1914	8	229	1,664	52	....	1,131	1,737
1915	10	....	344	2	....	....	345
1916	6	211	5,391	78	....	....	5,442
1917	5	146	3,963	147	9,971	....	4,084
1918	4	602	25	198	61,810	....	15,490
Increase or decrease, 1918	−1	+456	−3,938	+51	+51,839	....	+11,406

[a] Includes both deep and placer mines.

The Maloney Blue Lead mine, near Hill City, was operated under a lease during a part of the year and from it was shipped the largest quantity of copper ore that has been produced in South Dakota since 1909, when the Continental smelter was operated for 66 days on ores from the Dakota-Calumet.

The Dakota-Calumet mine shipped a small quantity of copper ore in 1918.

A small quantity of placer gold was recovered from Battle and Rapid creeks.

GOLD, SILVER, AND COPPER IN WYOMING.

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

The total value of gold, silver, and copper produced at mines in Wyoming in 1918 was $212,472, as compared with $560,181 in 1917. The copper alone was valued at $210,636. There were 12 producing mines, a decrease of 4 deep and 1 placer, as compared with 1917. The quantity of ore sold or treated was 2,870 tons, as compared with 6,335 tons in 1917. The deep mines yielded $871 in gold, 965 ounces of silver, and 852,777 pounds of copper. There was no placer production in 1918.

Mine production of gold, silver, and copper in Wyoming, 1917 and 1918.

Year.	Ore.	Gold.[a]		Silver.[a]		Copper.[a]		Total value.
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Short tons.	*Fine ounces.*		*Fine ounces.*		*Pounds.*		
1917	6,335	181.98	$3,762	3,415	$2,814	2,027,857	$553,605	$560,181
1918[b]	2,870	42.14	871	965	965	852,777	210,636	212,472
Decrease	3,465	139.84	2,891	2,450	1,849	1,175,080	342,969	347,709

[a] Includes placer production in 1917; no placer production in 1918.
[b] All ore in 1918 was copper smelting ore.

Mine production of gold, silver, and copper in Wyoming, 1842–1918.[a]

Period.	Gold.	Silver.		Copper.		Total value.
	Value.	Quantity.	Commercial value.	Quantity.	Value.	
		Fine ounces.		*Pounds.*		
1842–1867	(b)					
1867–1870	$396,100	3,170	$4,098			$400,198
1871–1880	400,000	3,240	4,115			404,115
1881–1890	67,500	2,940	3,126	1,395,287	$230,521	301,147
1891–1900	131,700	1,400	943	7,541,647	1,257,649	1,390,292
1901–1910	130,259	45,983	26,896	16,906,466	2,579,095	2,736,250
1911	19,200	725	384	130,499	16,312	35,896
1912	22,235	265	163	25,080	4,138	26,536
1913	24,184	957	578	385,239	59,712	84,474
1914	5,006	116	64	17,421	2,317	7,387
1915	14,592	840	426	447,246	78,268	93,286
1916	20,566	5,524	3,635	2,610,622	642,213	666,414
1917	3,762	3,415	2,814	2,027,857	553,605	560,181
1918	871	965	965	852,777	210,636	212,472
	1,235,975	69,540	48,207	32,340,141	5,634,466	6,918,648

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[a] For yearly output and authority for each, see U. S. Geol. Survey Mineral Resources, 1912, pt. 1, p. 925. 1913.
[b] Small; unknown.

MINING INDUSTRY.

Although the production of the Sunrise mine decreased about 50 per cent, the Hartville district, Platte County, maintained its place as the principal producing district in Wyoming in 1918. The Rambler property, at Holmes, was operated only half the year. Several cars of copper ore were shipped by the Atlas Copper Co. from Tie Siding.

Construction of a 400-ton concentrating mill was begun at the Elkhorn mine, in the Elk Mountain district. A small quantity of copper ore was shipped from the Encampment district. Several cars of copper ore were shipped from the Williams-Luman property, in the Copper Mountain district. A small quantity of ore was shipped from the Silver Crown district.

REVIEW BY COUNTIES.[1]

ALBANY COUNTY.[2]

The Rambler mine, near Holmes, was operated during the first half of 1918. Shipments were made of several cars of ore carrying gold, silver, platinum, palladium, and copper.

At Tie Siding development work was carried on by the Atlas Copper Mining Co. Copper smelting ore was shipped to Omaha.

BIG HORN COUNTY.[3]

No work was done in this county in 1918.

CARBON COUNTY.[4]

Development work was carried on at the Elkhorn mine, in the Elk Mountains district. All ore mined in 1918 was stored waiting completion of the 400-ton concentrating mill, work on which was begun in 1918.

Several cars of copper ore were shipped from the Encampment district.

On January 1, 1919, the property of the United Smelters Railway & Copper Co.[5] was purchased by the Morse Bros. Co., of Denver, which plans to build a mill for the treatment of the old smelter slag dump.

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[1] In this review the footnote references indicate publications containing information on the geology of the respective regions.

[2] Emmons, S. F., Platinum in copper ores in Wyoming: U. S. Geol. Survey Bull. 213, pp. 94–97, 1903. Kemp, J. F., Platinum in the Rambler mine, Wyo.: U. S. Geol. Survey Mineral Resources, 1902, pp. 244–250, 1904. Platinum in Wyoming: Eng. and Min. Jour., Mar. 4, 1911, p. 460. Concentration of platiniferous copper ore at the Rambler mine, Wyo.: Met. and Chem. Eng., February, 1911, pp. 75–78. Spencer, A. C., The Atlantic gold district and the North Laramie Mountains: U. S. Geol. Survey Bull. 626, pp. 56–77, 1916.

[3] Darton, N. H., U. S. Geol. Survey Geol. Atlas, Bald Mountain-Dayton folio (No. 141), and Cloud Peak-Fort McKinney folio (No. 142), 1906; Geology of the Bighorn Mountains; U. S. Geol. Survey Prof. Paper 51, 1906. Fisher, C. A., Geology and water resources of Bighorn Basin, Wyo.; U. S. Geol. Survey Prof. Paper 53, 1906.

[4] Spencer, A. C., Mineral resources of the Encampment copper region, Wyo.: U. S. Geol. Survey Bull. 213, pp. 158–162, 1903; also Copper deposits of the Encampment district, Wyo.: U. S. Geol. Survey Prof. Paper 25, 107 pp., 1904. See also Spencer, A. C., Reconnaissance examination of the copper deposits at Pearl, Colo.: U. S. Geol. Survey Bull. 213, pp. 163–169, 1903.

[5] See Min. and Sci. Press, Jan. 4, 1919, p. 25, and Feb. 1, 1919, p. 163.

CONVERSE COUNTY.[1]

No mining was done in the North Laramie Peak district, nor in the Cottonwood Creek district.

CROOK COUNTY.

On the property of the Occidental Gold Mining & Milling Co., on Sand Creek, 12 miles from Beulah, assessment work was done, consisting of building roads, flumes, and pipe lines.

No work was done in the Bear Lodge district.[2]

FREMONT COUNTY.

Atlantic City (*South Pass*) *district.*[3]—No production was made from this district in 1918.

Copper Mountain district.—Several cars of copper ore were shipped from the Williams-Luman property.

Gold placers on Wind and Big Horn rivers.[4]—There was no output from these deposits.

GOSHEN COUNTY.

In the Muskrat district development work only was done.

JOHNSON COUNTY.[5]

No work was done in the Big Goose, Bull Camp, and Kelly Creek districts.

LARAMIE COUNTY.

A small quantity of copper ore was shipped from properties in the Silver Crown district, near Hecla.

LINCOLN COUNTY.[6]

No production was reported from this county.

Lincoln County was formed in 1915 from the northern part of Uinta County and now includes not only the greater part of the old Uinta County but all the mining area.

NATRONA COUNTY.

No work was done in the Casper Mountain district, 10 miles south of Casper.

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[1] Spencer, A. C., U. S. Geol. Survey Bull. 213, pp. 66–71, 80–81, 1903.

[2] Darton, N. H., U. S. Geol. Survey Geol. Atlas, Sundance folio (127), 1905.

[3] Trumbull, L. W., Atlantic City gold mining district, Fremont County, Wyo.: Wyoming State Geologist Bull. 7, ser. B, 1914. Spencer, A. C., The Atlantic gold district and the North Laramie Mountains: U. S. Geol. Survey Bull. 626, pp. 1–45, 1916.

[4] Schrader, F. C., Gold placers on Wind and Big Horn rivers, Wyo.: U. S. Geol. Survey Bull. 580, pp. 127–145, 1915.

[5] Darton, N. H., U. S. Geol. Survey Geol. Atlas, Bald Mountain-Dayton folio (No. 141) and Cloud Peak-Fort McKinney folio (No. 142), 1906; Geology of the Bighorn Mountains: U. S. Geol. Survey Prof. Paper 51, 1906.

[6] Schultz, A. R., Gold development in central Uinta County, Wyo., and at other points on Snake River: U. S. Geol. Survey Bull. 315, pp. 71–88, 1907.

PARK COUNTY.

No mining was done in the Sunlight and Kirwin district.[1]

PLATTE COUNTY.[2]

Shipments of copper-silver ore were continued from the Sunrise mine, in the Hartville district.[3]

SHERIDAN COUNTY.

No work was done on the prospects in the Black Mountain, Wolf Creek, and Tongue River districts.

UINTA COUNTY.

(See Lincoln County.)

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[1] Hewett, D. F., The ore deposits of Kirwin, Wyo.: U. S. Geol. Survey Bull. 540, pp. 121–132, 1914.

[2] The northwestern part of Laramie County prior to 1913.

[3] Smith, W. S. T., U. S. Geol. Survey Geol. Atlas, Hartville folio (No. 91), 1903. Ball, S. H., Copper deposits of the Hartville uplift, Wyoming: U. S. Geol. Survey Bull. 315, pp. 93–107, 1907.

ARSENIC.

By James M. Hill.

PRODUCTION.

The white arsenic produced in the United States in 1918 amounted to 6,323 short tons, valued at $1,213,000. This was a slight increase over the output in 1917, which was 6,151 short tons, valued at $1,118,313. Besides producing white arsenic one company reported that it produced metallic arsenic.

The table below shows the production of white arsenic from the beginning of the industry in this country.

White arsenic (As_2O_3) produced in the United States, 1901-1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1901	300	$18,000	1910	1,497	$52,305
1902	1,353	81,180	1911	3,132	73,408
1903	611	36,691	1912	3,141	190,757
1904	36	2,185	1913	2,513	159,236
1905	754	35,210	1914	[a]4,670	313,147
1906	737	63,460	1915	[b]5,498	302,116
1907	1,751	163,000	1916	[c]5,986	555,187
1908	(d)	(d)	1917	6,151	1,118,313
1909	1,214	52,946	1918	6,323	1,213,000

[a] This quantity includes 200 tons of crude arsenic trioxide carrying about 97.5 per cent of As_2O_3.

[b] This quantity includes 353 tons of crude arsenic trioxide carrying about 97.5 per cent of As_2O_3.

[c] This quantity includes 152 tons of crude arsenic trioxide carrying about 97.5 per cent of As_2O_3.

[d] Only two firms produced arsenic in the United States in 1908, so that the figures can not be published without disclosing confidential returns.

The refined arsenic produced is reported to be above 99.5 per cent of As_2O_3.

IMPORTS.

The imports of white arsenic and arsenic sulphide, or orpiment, in 1918 were nearly double the imports in 1917.

Arsenic compounds imported and entered for consumption in the United States, 1909-1918.

Year.	Arsenic or arsenious acid (white arsenic, As_2O_3).		Arsenic and sulphide of, or orpiment.		Sheep dip.		Paris green and London purple.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (pounds).	Value.	Quan tity (pounds).	Value.
1909	445	$31,235	3,591	$272,493	1,574	$9,615	183,765	$20,370
1910	1,348	76,282	3,791	238,024	....	24,279	181,363	14,648
1911	1,921	116,948	2,175	127,375	....	20,642	126,191	4,972
1912	3,103	200,616	3,053	228,125	....	41,556	162,272	6,950
1913	1,519	133,597	3,182	276,849	....	40,036	99,692	4,431
1914	1,594	109,121	2,034	164,592	....	34,556	15,476	2,235
1915	1,400	113,677	1,783	154,099	....	19,916	21,056	4,069
1916	1,071	107,876	1,092	124,818	....	20,134	23,461	5,028
1917	1,178	264,534	2,777	410,341	....	15,848	48	189
1918	1,847	441,212	4,842	840,600	....	23,538	....	....

EXPORTS.

No arsenic produced in the United States is exported but some imported arsenic is reexported, as shown in the following table:

Foreign arsenic and sulphide of, or orpiment, reexported, 1913-1918.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1913	60,000	$3,135	1916	1,761	$1,256
1914	700	79	1917	113,600	15,840
1915	9,776	526	1918	80,050	12,017

CONSUMPTION.

By far the greater part of the domestic white arsenic consumed in the United States in 1918 was used in preparing insecticides and weed killers, the total quantity so used in 1918 being about 2,000,000 pounds. Nearly 1,000,000 pounds was used in the glass industry, and a small quantity in the preparation of drugs.

The stocks of white arsenic in the hands of producers at the end of 1918 were approximately 449 short tons, or about 7 per cent of the production.

PRICE.

The price of white arsenic was fixed by the Food Administration at 9 cents a pound in carload lots early in 1918, though the price had been as high as 15 cents a pound. Announcement was made on December 12, 1918, of the cessation of price fixing by the Government, and at the same time permission was granted to export arsenic and arsenical insecticides.

BISMUTH.

By James M. Hill.

PRODUCTION.

In 1918 bismuth was recovered by only one company in the United States, the American Smelting & Refining Co., which obtains this product from the refining of lead bullion. Statistics of production can not be published.

IMPORTS AND EXPORTS.

Bismuth imported for consumption in the United States, 1913–1918.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1913	117,747	$213,257	1916	76,723	$195,975
1914	90,505	165,208	1917	69,250	142,300
1915	44,362	108,288	1918	135,700	277,273

No exports of bismuth are recorded.

PRICES.

The prices quoted were practically stationary at $3.50 a pound in 500-pound lots throughout the year 1918, though there was a drop to $3.35 a pound in February and March.

SELENIUM.

By JAMES M. HILL.

PRODUCTION.

The production of selenium in 1918 was 103,694 pounds, valued at approximately $206,540. As compared with 39,630 pounds, valued at $70,000, produced in 1917, this was an increase of 162 per cent in quantity and 195 per cent in value. Selenium was recovered in 1918 as a by-product in the electrolytic copper refineries operated by the Raritan Copper Works, United States Metals Refining Co., Nichols Copper Co., and American Smelting & Refining Co.

IMPORTS.

As will be seen by the following table, the imports of selenium and selenium salts into the United States have never been large, but in 1918 the domestic producers were apparently able to supply the entire demand.

Selenium and selenium salts imported for consumption in the United States, 1913–1918.

1913	$320	1916	$302
1914	43	1917	2,236
1915	59	1918	0

CONSUMPTION AND STOCKS.

The reported sales of selenium during 1918 amounted to 54,509 pounds, about 60 per cent of which was used as a coloring and deoxidizing agent by the glass industry.

Stocks in the hands of producers at the end of the year were about 14,500 pounds, or 27 per cent of the apparent consumption.

PRICE.

Producers reported prices varying from $1.60 to $2.50 a pound. Quoted prices showed a high of $3.25 a pound during the first eight months of the year but dropped to $2.75 a pound during the last quarter.

TELLURIUM.

By James M. Hill.

There was a small demand for tellurium in 1918, but as only one producer, the Raritan Copper Works, reported production or sale of this metal, it is not possible to give figures showing production. Stocks of tellurium are apparently large as compared with the annual consumption.

PLATINUM AND ALLIED METALS.

By James M. Hill.

INTRODUCTION.

For the first four months of 1918 platinum metals were sold in open market, but consumption in unessential industries had been voluntarily restricted, the largest consumption being in the expansion of plants for the production of sulphuric acid and the fixation of nitrogen. Even with the lessened use of platinum by the jewelers it became evident that there would be a shortage of platinum metals for war purposes if more drastic means of control were not employed.

On February 23, 1918, the stocks of the larger producers of platinum were requisitioned by the Ordnance Department in order that there should be no uncertainty as to the supplies of platinum for certain military purposes. As the quantity of platinum made available to the Government by this requisition did not appear sufficient, a second requisition, which covered the stocks of 947 producers and consumers, was issued on May 1, and this was followed on July 1 by a third requisition, which covered the stocks of 1,555 producers and consumers.

Under the terms of the requisitions it was possible for the Government to know definitely what platinum metals were available and so to allocate the supply that it would be used most effectively. The requisition orders were made by the Ordnance Department but were administered by the platinum section of the War Industries Board. Much credit is due to the members of this section for the way in which they dealt with a delicate situation and for their efforts to promote the conservation of supplies.

Added powers were given to the platinum section under the explosives act in the promulgation on August 17, 1918, of "Rules and regulations under the act of October 6, 1917 (40 Stat., 385), as amended by the act of July 1, 1918 (Public, No. 181), limiting the sale, possession, and use of platinum, iridium, and palladium and compounds thereof."

With the signing of the armistice the need for strict regulation passed, and on November 14 the "Rules and regulations" were revoked by the Secretary of the Interior. The requisition orders were likewise canceled December 1, 1918, though a certain measure of control of the market was still possible through the regulation of imports and exports by the War Trade Board.

DOMESTIC PRODUCTION.

CRUDE PLATINUM.

Crude placer platinum was produced from mines in Alaska, California, Oregon, and Washington in 1918.

Buyers and refiners reported purchases of 433 ounces of domestic crude platinum, which, at the average price of $91 an ounce, was valued at $39,403.

Incomplete returns from placer miners producing platinum indicate that the production in 1918 was at least 647 ounces of crude platinum, of which about 82 per cent was from California, 9 per cent from Alaska, 8 per cent from Oregon, and 1 per cent from Washington. The output in 1918 of 647 ounces compares with the production of 605 ounces in 1917. In view of the continued high prices paid for crude platinum, it may reasonably be stated that the domestic production of crude placer platinum will not exceed 700 ounces a year, and may be less if the price is much reduced.

REFINED PLATINUM METALS.

Reports received from refiners of platinum, gold bullion, nickel, and copper indicate that 59,753 troy ounces of refined new metals of the platinum group was recovered in 1918, of which about 10,693 troy ounces is believed to be of domestic origin.

New platinum and allied metals recovered by refiners, 1915–1918, in troy ounces.

Year.	Platinum.	Iridium.	Iridosmine-osmiridium.	Palladium.	Rhodium.
1915	6,495	274	355	1,541	....
1916	24,518	370	315	2,885	....
1917	33,009	210	833	4,779	....
1918	54,399	465	539	4,024	326

Dealers and refiners reported sales in 1918 of 45,583 ounces of secondary platinum metals derived from refining scrap and sweeps. The figures that make up this total probably represent some duplication, as the same metal may be handled as scrap several times in a year.

Secondary platinum and allied metals sold, 1915–1918, in troy ounces.

Year.	Platinum.	Iridium.	Palladium.
1915	42,149	863	958
1916	45,156	1,535	1,284
1917	59,007	9,832	3,347
1918	40,378	3,410	1,795

The decrease in sales of secondary platinum metals was in large part due to the prohibition on the use of these metals in those industries which were not considered essential to the conduct of the war.

STOCKS OF PLATINUM METALS.

Refiners and dealers in platinum metals reported stocks of 64,814 ounces on December 31, 1918. More than half of this quantity was in manufactured articles.

Stocks of platinum metals on hand December 31, 1918, in troy ounces.

	Unmanufactured.	Manufactured articles.
Platinum	17,740	33,764
Iridium	2,259	965
Palladium	7,141	2,945

WORLD'S PRODUCTION.

Statistics of the world's production of platinum and allied metals are at best estimates, though they are derived from the most reliable information obtainable. There are no reliable data upon which to base estimates of the production of platinum in Russia. In fact it seems doubtful whether any platinum was mined in that country in 1918, as much of the fighting during the later part of the year was in the vicinity of the platinum fields.

Estimated world's production of crude platinum, 1911–1918, in troy ounces.

Country.	1911	1912	1913	1914	1915	1916	1917	1918
Borneo, India, and Sumatra			200	(a)	[b]18	[b]9	[c]52	(a)
Canada	30	30	50	30	100	60	80	75
Colombia	12,000	12,000	15,000	17,500	18,000	25,000	32,000	35,000
New South Wales and Tasmania	470	778	1,500	1,248	303	222	330	811
Russia	300,000	300,000	250,000	241,200	124,000	63,900	50,000	(a)
United States	628	721	483	570	742	750	605	647
	313,128	313,529	267,233	260,548	143,163	89,941	83,067	36,533

[a] No basis for estimate. [b] India only. [c] Dutch East Indies and India.

IMPORTS.

The imports of platinum and allied metals for consumption in 1918 as given by the Bureau of Foreign and Domestic Commerce were larger than for 1917. The figures in the table below, however, are somewhat misleading, as they include the 21,000 ounces of platinum from Russia which reached the United States late in 1917.

Platinum and allied metals imported for consumption in the United States, 1917 and 1918.

Metal.	1917		1918	
	Quantity (troy ounces).	Value.	Quantity (troy ounces).	Value.
Platinum or crude platinum and unmanufactured products, ingots, bars, sheets, wire	30,207	$2,408,188	54,963	$4,949,855
Platinum, manufactured products, vases, retorts, etc	(a)	1,347	(a)	8,597
Iridium	3,619	378,678	1,126	126,282
Osmiridium	259	25,456	427	46,321
Osmium	400	23,359		
Palladium	1,239	117,192	240	36,853
	35,724	2,954,220	56,756	5,167,908

[a] Quantity not given.

Platinum imported into the United States, 1917 and 1918.[a]

	Unmanufactured.		Ingots, bars, etc.		Manufactured products, vases, etc.	Total value.
	Quantity (troy ounces).	Value.	Quantity (troy ounces).	Value.		
1917.						
France	192	$20,422	1,705	$143,162	$80	$163,664
Netherlands					254	254
England	2,044	144,570	1,570	102,763		247,333
Canada	46	3,792	420	37,495	48	41,335
Panama	38	2,629	5	470		3,099
Mexico	9	749	29	3,000		3,749
Brazil			3	300		300
Chile	83	6,800				6,800
Colombia	23,445	1,893,922	438	32,193		1,926,115
Venezuela	174	14,136				14,136
Dutch East Indies	49	4,430				4,430
China	66	3,940				3,940
	26,146	2,095,390	4,170	319,383	382	2,415,155
1918.						
France	376	39,006				39,006
England	193	17,948	202	19,910	11,458	49,316
Netherlands					433	433
Canada	75	7,924	200	20,978	[b] 1,634	30,536
Costa Rica			3	500		500
Panama	471	43,439	872	75,040		118,479
Cuba			6	575		575
Brazil	27	2,312				2,312
Chile	142	12,099				12,099
Colombia	22,974	1,973,090	7,569	657,524	[b] 700	2,631,314
Dominican Republic			3	214		214
Peru	3	300				300
Ecuador			2	219		219
Venezuela	16	1,610	8	438		2,048
China	423	34,267				34,267
Dutch East Indies	21	1,339				1,339
Japan	112	11,406	228	26,251		37,657
Russia in Asia	21,000	2,000,000				2,000,000
British South Africa			36	3,366		3,366
	45,833	4,144,740	9,129	805,015	14,225	4,963,980

[a] Does not include platinum manufactures "Not specially provided for" in the tariff act, upon which a duty of 50 per cent is imposed.

[b] Six months, January to June.

As will be seen by comparing the imports of platinum for 1917 and 1918 as shown by the tables above, except for the 21,000 ounces of Russian platinum, the great bulk of the supply came from South America, principally Colombia, which sent 30,543 ounces to the United States in 1918. The platinum imported from Panama is presumably of Colombian origin, and that imported from China and Japan is no doubt Russian. Europe supplied only 771 ounces during 1918, as compared with 5,511 ounces in 1917.

MARKET AND PRICES.

REFINED METALS.

The open-market price for platinum in January was $105 to $108 an ounce. The price of platinum rose slightly in February, but in March and April it remained stationary at $108 an ounce. Palladium at the beginning of the year was $135 an ounce, but the price rose from $140 on March 2 to $145 to $150 at the end of the month and remained at $150 an ounce until May. Iridium is rarely quoted, but in April it was reported to be selling at $150 an ounce. In May under the requisition order the prices of platinum metals were fixed as follows: Platinum, $105 a troy ounce; palladium, $135 a troy ounce; and iridium, $175 a troy ounce. These prices not only governed the value of refined metals but were interpreted to include the platinum-metal content of scrap materials and crude platinum. With the cancellation of the requisition order on December 1, 1918, prices advanced and sales of platinum were reported at as high as $140 an ounce, though most reports indicated that prices ranged from $105 to $110 an ounce for platinum and from $125 to $135 an ounce for palladium. A stabilizing influence on the platinum market was exerted by the Government's announcement that its stocks of platinum, amounting to several thousand ounces, would be disposed of at $105 an ounce.

Average prices of platinum per troy ounce in the New York market, 1913–1918.[1]

1913	$44.88
1914	45.06
1915	49.63
1916	83.40
1917	102.82
1918:	
January	105.92
February	107.68
March	108.00
April	108.00
May	106.27
1918:	
June	$105.00
July	105.00
August	105.00
September	105.00
October	105.00
November	105.00
December	105.54
Average	105.95

The prices reported to the United States Geological Survey by refiners of the platinum group of metals varied considerably in 1918. In the following table fair average prices are given, and these prices have been used by the Geological Survey in all computations.

Average price per troy ounce of refined metals of the platinum group, 1914–1918.

Metal.	1914	1915	1916	1917	1918
Platinum	$45	$55	$84	$103	$105
Iridium	65	83	94	150	175
Iridosmine	33	35	45	80	90
Palladium	44	56	67	110	135

CRUDE PLATINUM.

The miners of California, Oregon, and Alaska received from $54 to $98 an ounce for their crude platinum in 1918, the average price being about $91 as compared with $90 for 1917. The principal buyers of crude platinum in the United States are:

American Platinum Works, Newark, N. J.
Baker & Co. (Inc.), Newark, N. J.
Pacific Platinum Works, Los Angeles, Calif.
R. & H. Platinum Works, 100 William Street, New York, N. Y.
Shreve & Co., San Francisco, Calif.
Wildberg Bros., San Francisco, Calif.
H. A. Wilson Co., Newark, N. J.

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[1] Eng. and Min. Jour., vol. 107, p. 76, 1919.

NOTES ON PLATINUM DEPOSITS.

UNITED STATES.

The Geological Survey received in 1918 many samples of supposed platinum-bearing ores. The great majority of these samples were found to carry no platinum. A few specimens were of interest. One in particular, a heavy chalcopyrite ore from the Copper King mine, in the New World district, Park County, Mont., carried about 0.3 ounce of platinum a ton.

ALASKA.

During 1918 rich gold, silver, and palladium bearing copper concentrates were shipped from the Saltchuck mine, in the Ketchikan district, southeastern Alaska. This ore is remarkable for its high content of palladium. The mine is well developed and equipped with flotation mill. The ores are largely bornite and chalcocite. The Seward Peninsula placers produced 56 ounces of platinum, mostly from dredges. There was also a production of platinum from Boob Creek, in the Tolstoi (Yukon) district, and from Slate Creek, in the Chistochina (Copper River) district.

CALIFORNIA.

Placer mines in California produced 530 ounces of crude platinum in 1918, as compared with 460 ounces in 1917. Dredges in Butte, Yuba, Calaveras, Amador, Sacramento, Merced, and Shasta counties saved 522 ounces as a by-product; hydraulic mines in Nevada, Trinity, Siskiyou, Humboldt, Plumas, and Mendocino counties saved 8 ounces.

NEVADA.

Copper-gold palladium ores were shipped during 1918 to the Palau Metals Co. and the Irvington Smelting & Refining Co. from the Boss mine, near Good Springs, Clark County, Nev.

OREGON.

Development of one of the old elevated beaches near Port Orford, Oreg., was reported to have begun on a considerable scale late in 1918, and there were some new installations in the vicinity of Bandon. The largest quantity of platinum produced in Oregon came from hydraulic mines near Waldo and Kerby, Josephine County. The total production from all mines in the State in 1918 was 58 ounces.

WASHINGTON.

Refiners reported very small purchases of crude platinum from Washington mines in 1918.

WYOMING.

At the Rambler mine, near Holmes, Albany County, Wyo., a fire in August, 1918, destroyed the surface equipment, but it is reported that the mine will be equipped and reopened as soon as possible.

OTHER COUNTRIES.

CANADA.

Considerable prospecting for platinum by the Government as well as by private individuals was in progress in Canada during 1918, and the results of this work may be made available to the general public,[1] as a large part of it was more or less under governmental supervision. Particular attention was given to the Tulameen and Quesnel River areas. A company is also prospecting on Olivine Mountain, in the Tulameen area, with a view of working the platiniferous dunite. On October 1, 1918, it was reported that the refining of platinum had been begun at the Dominion assay office, Vancouver.

COLOMBIA.

Exports of platinum from Colombia to the United States maintained a fairly steady level of 2,700 ounces a month throughout 1918, the total quantity imported into the United States during the year being 30,543 ounces. The second dredge of the American Co. operating on Rio Condoto, was not completed owing to difficulties of transportation and labor, but it should come into operation in 1919. A British company is about to begin the construction of a dredge on the Tamana. In July, 1919, the long-expected export duty of 5 per cent ad valorem on platinum was imposed by the Colombian Government.

RHODESIA.

According to Zealley[2] platinum has been found in ore from the Dream Reef, near Fort Gibb, in the Gwilo district, Rhodesia. The ore is apparently a segregated mass of magnetite, chromite, and heavy silicates in a large mass of partly serpentinized dunite, which here forms the main mass of the "Great Dike." Copper and nickel oxidation products are present in the platinum-bearing material.

A 40-pound sample of ore was concentrated to 2 pounds, and the concentrates assayed 1 pennyweight 20 grams (or 0.054 troy ounce) per ton. This would indicate that although platinum is present it is hardly in commercial quantity. No attempt was made to determine the extent of the ore body.

RUSSIA.

There is no real information to be had concerning the conditions in the Russian platinum field. Apparently none of the dredges were operated in 1918, and a report has been received that many of them were destroyed and that the little platinum that was mined was won presumably by crude methods. It seems safe to say that it will be at least a year and probably nearer three years after stable conditions return in Russia before the Russian field can hope to get back to its pre-war rate of production.

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[1] O'Neill, J. J. The platinum situation in Canada, 1918: Canada Geol. Survey Summary Report, 1918, pt. G, 1919.

[2] Zealley, A. E. V., The occurrence of platinum in southern Rhodesia: Southern Rhodesia Geol. Survey Short Papers No. 3, Mar. 20, 1918.

TASMANIA.

There was considerable activity in osmiridium mining in the northwestern districts of Tasmania during 1918. About 200 men were engaged in the work, and it is reported that some of the more fortunate miners were making as much as £20 a week.[1] In 1918 the osmiridium recovered by these workers amounted to 810.6 ounces, as compared with 218.2 ounces in 1917. The average price paid for crude osmiridium in the Tasmanian markets during 1918 was £20 7s. ($98.90) an ounce, the highest point, £37 7s. 6d. ($181.62) an ounce, being reached just before the armistice was signed, but after that time the price broke to £15 ($72.90) an ounce.

USES OF PLATINUM.

Under the rather close control of the use of platinum metals in the United States in 1918 the consumption by the industries was not the same as in years of unrestricted use. According to reports of refiners and dealers who sold platinum in 1918 the electrical and chemical industries consumed approximately 66 per cent of the platinum metals used, the dental industry 17 per cent, and the jewelry industry 12 per cent.

Platinum metals used in the United States in 1918 by consuming industries, in troy ounces.

Industry.	Platinum.	Iridium.	Palladium.	Total.	Percentage of total.
Chemical	45,391	717	834	46,942	40.76
Electrical	24,982	3,107	594	28,683	24.91
Dental	11,461	418	7,371	19,250	16.71
Jewelry	13,541	721	42	14,304	12.43
Miscellaneous	5,435	339	212	5,986	5.19
	100,810	5,302	9,053	115,165	100.00

Prior to the war, when the average annual consumption of platinum metals in the United States was about 165,000 ounces, it was estimated that the jewelry and dental industries used 75 per cent of the platinum metals consumed, the electrical industry 20 per cent, and the chemical industry 5 per cent. It is therefore evident that during our time of need in 1918 the ratio of consumption by the several industries was quite reversed.

Pure platinum is required for chemical work of all sorts, but for other uses the iridium alloys are used. Electrical platinum contains 15 to 50 per cent of iridium but averages 25 per cent, and jeweler's platinum carries about 10 per cent of iridium. Palladium, another of the platinum group of metals, is also of importance, chiefly in the form of palladium-gold alloys, which can be used to replace platinum in dental products and jewelry. Rhodium, one of the rarer members of the platinum group, has a limited use in electric pyrometers. Osmium and ruthenium, the remaining members of the platinum group, appear to have little use, though osmium, when properly handled, can be employed as a substitute for iridium to harden platinum alloys.

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[1] Industrial Australian and Mining Standard, vol. 60, Dec. 19 and 26, 1918.

The essential uses of platinum metals are in the chemical and electrical industries, and probably their use by the dental industry should also be classed as essential. Pure platinum is required in the chemical industry for catalyzers in the manufacture of sulphuric acid by the contact process and in the manufacture of nitric acid from ammonia. For the sulphuric acid industry platinum chloride is the primary material containing platinum. In nitric acid plants very fine mesh platinum gauze is used for the catalyzer. Pure platinum utensils of various kinds, including crucibles, dishes, tongs, and triangles, are required in every chemical laboratory. It is possible to substitute palladium-gold alloys, or even gold, nickel, nichrome, and silica for some utensils, but no substitutes have yet been found which will entirely replace platinum in chemical ware.

Platinum-iridium alloys have been used very extensively by the electrical industry, but substitutes are constantly being developed. Tungsten, molybdenum, and nickel-chromium alloys are the principal substitutes used so far, but their use has not done away with the need for platinum in the industry. The principal use of platinum-iridium alloys in electrical work is in contact points, and the proportion of iridium necessary in the alloys is directly dependent on the intensity of the current passing through the contacts and the speed at which the contacts move. Probably the largest consumption of platinum alloy is in the manufacture of telephone and telegraph equipment, including sending and receiving instruments, switchboards, and relays. There is also a large consumption of platinum for contact points in magnetos used for various kinds of internal-combustion engines. Automobile makers are, however, developing starting systems which do not require platinum in their construction, so the future demand from that quarter will probably diminish.

Platinum has an important use in dentistry, though palladium-gold alloys are being used as substitutes. It would appear, however, that the substitutes are not entirely satisfactory. The principal uses are for pins for crown work, pins for fastening artificial teeth to plates, and foil for making molds of cavities in which to bake porcelain fillings.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE EASTERN STATES.

(MINES REPORT.)

By James M. Hill.

MINE PRODUCTION.

The total value of the output of gold, silver, copper, lead, and zinc in the Eastern States was $27,517,488 in 1918, a decrease of over 26 per cent from the production in 1917. The total value is distributed among the various metals as follows: Gold, $14,352; silver, $106,585; copper, $4,411,058; lead, $366,243; zinc, $22,619,250.

As will be seen from the following table, the decrease in value is due to large decreases in the output of gold, copper, lead, and zinc, and reflects the condition of mining in the Eastern States.

Mine production of gold, silver, copper, lead, and zinc in the Appalachian States, 1917–18.

Year.	Ore sold or treated.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917....................	2,709.201	$29,227	106,450	18,061,068	6,879,053	312,566,805	$37,521,025
1918....................	2,355,688	14,352	106,585	17,858,535	5,158,329	248,563,192	27,517,488
Increase or decrease.	−353,513	−14,875	+135	−202,533	−1,720,724	−64,003,613	−10,003,537

GOLD.

The mine production of gold in the Eastern States in 1918 was only 694.27 fine ounces, having a total value of $14,352, as compared with 1,413.86 fine ounces, valued at $29,227, in 1917. Of this output the placers yielded 318.84 ounces, the siliceous gold ores 83.68 ounces, and copper ores 291.75 ounces. Very few gold mines were worked during 1918, owing to the continued increase of cost of operation and the fixed price of the product.

SILVER.

In 1918 the mine production of silver in the Eastern States was 106,585 fine ounces, valued at $106,585, an increase of 135 ounces over the output in 1917. The largest production was from copper ores, 105,212 ounces, and the smallest from siliceous gold ores, 15 ounces, as is shown by the second table below. About 1,330 ounces of silver were recovered from lead-zinc ores produced in New Hampshire and lead ore shipped from New York State.

Mine production of gold and silver in the Eastern States in 1918, by States.

State.	Gold.		Silver.		Increase or decrease in value compared with 1917.	
	Quantity.	Value.	Quantity.	Value.	Gold.	Silver.
	Fine ounces.		*Fine ounces.*			
Alabama and Georgia	323.62	$6,690	27	$27	−$2,461	− $19
Maine, Maryland, New Hampshire, New York, and Vermont	37.01	765	11,107	11,107	+ 628	+ 9,698
North Carolina and South Carolina	78.90	1,631	17	17	−11,639	− 900
Tennessee	235.39	4,866	93,620	93,620	− 460	+12,001
Virginia	19.35	400	1,814	1,814	− 943	− 1,909
Total, 1918	694.27	14,352	106,585	106,585	....	....
Total, 1917	1,413.86	29,227	106,450	87,714	....	....
Increase or decrease, 1918	−719.59	−14,875	+135	+18,871	−14,875	+18,871

Mine production of gold and silver in the Eastern States in 1918, by sources, in fine ounces.

State.	Gold.			Silver.		
	Placers.	Dry or siliceous ores.	Copper ores.	Placers.	Dry or siliceous ores.	Copper ores.[a]
Alabama and Georgia	239.94	83.68	....	12	15	....
Maine, New Hampshire, New York, and Vermont	....	....	37.01	....	....	11,107
North Carolina and South Carolina	78.90	....	....	17	....	....
Tennessee	....	....	235.39	....	....	93,620
Virginia	....	....	19.35	....	....	1,814
Total, 1918	318.84	83.68	291.75	29	15	106,541
Total, 1917	336.41	416.17	661.28	43	148	106,259

[a] Includes silver from lead ore produced in New York and lead-zinc ore produced in New Hampshire.

COPPER.

The mine production of copper in the Eastern States in 1918 was 17,858,535 pounds, valued at $4,411,058, a decrease in quantity from 1917 of 202,533 pounds and in value of $519,614. This copper was largely derived from Tennessee ores, but some came from the copper-bearing magnetite ores of Pennsylvania and from copper ores mined in Georgia, Maine, and Vermont. The total quantity of ore and tailings treated to produce this copper was 983,062 tons, showing an average yield of copper of approximately 0.9 per cent, or 18 pounds a ton.

LEAD.

The mine production of lead in the Eastern States in 1918 was 5,158,329 pounds, valued at $366,243, a decrease of 25 per cent in quantity and of about 38 per cent in value. Tennessee mines produced 3,410,400 pounds, 1,629,327 pounds were produced in Virginia, and there was also a production from New Hampshire and New York.

ZINC.

The production of zinc in the Eastern States in 1918 was 248,563,192 pounds, valued at $22,619,250, a decrease in quantity of 64,003,613 pounds from the production in 1917.

New Jersey, with a production of 196,940,000 pounds, produced more zinc than all the remaining Eastern States. Tennessee was second, with an output of 42,141,311 pounds. New York and Virginia were next in rank with approximately 7,552,000 and 1,902,000 pounds, respectively. There was also a small output from New Hampshire.

REVIEW BY STATES.

ALABAMA.

The Gold Log, near Talladega, and two placers, one in Cleburne County and the other in Chilton County, marketed metals during 1918. The total production for the State was 38.55 ounces of gold and 2 ounces of silver, the great bulk of which was produced at the Gold Log mine.

GEORGIA.

In 1918 mines in Georgia produced 285.07 ounces of gold, valued at $5,893, 25 ounces of silver, and 397,078 pounds of copper, a decrease of $996 in the value of gold and of 21 ounces in the quantity of silver from the production of 1917. The production of copper in 1918 was due to the operation of some of the mines in the Ducktown district that lie in Fannin County, Ga.

Of the output in 1918 placer mining furnished 237.28 ounces of gold and 12 ounces of silver, the remainder coming from deep mines. The deep gold mines in operation in the State treated 1,000 short tons of siliceous ore, from which 47.79 ounces of gold and 13 ounces of silver were recovered.

Mine production of gold, silver, and copper in Georgia, 1917–18.

Year.	Number of mines.		Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Total value.
	Placer.	Deep.					
			Short tons.		*Fine ounces.*	*Pounds.*	
1917	13	6	44,610	$6,889	46	930,691	$261,005
1918	7	2	15,960	5,893	25	397,078	103,996
Decrease	6	4	28,650	996	21	533,613	157,009

[a] Includes placer production.

Seven placer mines were operated in Haralson, Lumpkin, Tallapoosa, and White counties, Ga. The White County placers, including the Loud mine, produced about 80 per cent of the gold obtained from placers in the State.

Only two deep gold mines reported production in 1918. The Pine Mountain mine in Douglas County, near Villa Rica, was reported closed.

The Columbia mine in McDuffie County was operated by the American Venture & Mines Corporation.

MAINE.

The American Smelting & Refining Co. continued operating the old Douglas mine, at Blue Hill, Maine, and treated the siliceous chalcopyrite ore by flotation, making a small production of copper, gold, and silver.

MARYLAND.

Apparently no mines were operated in Maryland in 1918.

NEW HAMPSHIRE.

A little ore was shipped from the Silver Lake mines, in Carroll County, N. H., in 1918, from which silver, lead, and zinc were recovered.

NEW JERSEY.

The production of New Jersey was, as usual, confined to the output of the Mine Hill and Stirling mines at Franklin Furnace, Sussex County. There were 672,791 tons of crude ore produced at those mines in 1918, which yielded a total of 196,940,000 pounds of zinc. It should be understood that only part of the zinc ore mined at Franklin Furnace is used directly for the manufacture of zinc. The greater part of this zinc is normally converted into oxide at works located in Pennsylvania.

NEW YORK.

The Northern Ore Co., operating the Brown and White mines, near Edwards, St. Lawrence County, N. Y., treated 40,850 tons of zinc-bearing ore, which yielded about 7,552,000 pounds of recoverable zinc.

A small shipment of silver-bearing lead ore was made by the Summitville Ore Concentrating Co.

NORTH CAROLINA.

Apparently no deep mines were operated in North Carolina in 1918. The output of gold, 78.90 ounces, valued at $1,631, and of silver, 17 ounces, valued at $17, was made from placer mines and "clean-ups" about closed mills, which is all credited as from placer mines.

Mine production of gold, silver, copper, and lead in North Carolina in 1917–18.

Year.	Number of mines.		Ore sold or treated.	Gold.	Silver.	Copper.	Lead.	Total value.
	Placer.	Deep.						
			Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	14	7	2,087	$12,187	1,110	124,991	2,583	$47,447
1918	5			1,631	17			1,648
Decrease	9	7	2,087	10,556	1,093	124,991	2,583	45,799

PENNSYLVANIA.

The Cornwall iron mines, in Lebanon County, Pa., now operated by the Bethlehem Steel Co., produced a copper concentrate from pyritiferous magnetite ore.

SOUTH CAROLINA.

No mines in South Carolina reported production in 1918. The McCormick Mining Co. is opening several mines near McCormick.

TENNESSEE.

The mine production of precious metals in Tennessee in 1918 was 235.39 ounces of gold, valued at $4,866, and 93,620 ounces of silver, all of which was derived from the coper ores of Polk County. This was a small reduction from the output of gold in 1917, and a decrease of 5,433 ounces of silver. There were 529,012 tons of copper ore treated in Polk County, from which 14,799,680 pounds of copper were produced. Some copper was saved by the Tennessee Copper Co. by leaching flue dust. Tennessee produced about 3,410,400 pounds of lead, which was obtained from mines in Washington County. The production of zinc in 1918 was 42,141,311 pounds, a decrease of 14,853,796 pounds from the output in 1917. Lead and zinc ores were produced at mines in Jefferson, Washington, and Union counties.

Mine production of gold, silver, copper, lead, and zinc in Tennessee, 1917–18.

Year.	Number of mines.		Ore sold or treated.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Copper.	Lead and zinc.							
			Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	2	5	1,533,983	$5,326	99,053	16,033,749	5,061,937	56,995,107	$10,712,985
1918	2	4	1,159,971	4,866	93,620	14,799,680	3,410,400	42,141,311	7,831,005
Decrease	....	1	374,012	460	5,433	1,234,069	1,651,537	14,853,796	2,881,980

VERMONT.

The Eureka mine, Orange County, Vt., was operated by the Pike Hills Mines Co., which has installed a 100-ton flotation mill.

The Ely Copperfield Associates operated the old Ely mine at West Fairlee, and the Vermont Copper Co. the Elizabeth mine at South Stafford. During 1918, 49,772 tons of copper ore were mined, which yielded 4.02 ounces of gold, 3,440 ounces of silver, and 1,116,384 pounds of copper, having a combined value of $279,270. All of the ore treated is concentrated and yielded 1 ton of concentrates from 10 tons of ore.

VIRGINIA.

The Austinville mines, operated by the Bertha Mineral Co., were the only mines in Virginia that reported work in 1918. A small quantity of gold and silver was, however, reported as recovered from pyritic ores smelted at Norfolk.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEVADA.[a]

(MINES REPORT.)

By V. C. Heikes.

PRODUCTION.

GENERAL STATEMENT.

In 1918 mines in Nevada produced 6,472,579 tons of ore, which, with placer bullion, contained gold, silver, copper, lead, and zinc valued at $48,528,124. This total represents a decrease in value of $5,896,456, as compared with $54,424,580 in 1917, from 6,473,519 tons of ore and placer bullion. There were 714 producers of ore and bullion in 1918, of which 54 were placers, against 852 lode producers and 91 placers in 1917. There was a decrease in the quantity of all the metals mentioned above and likewise in the value, with the exception of silver. The value of the copper output, which represented more than 59 per cent of the total value, was $28,730,161, a decrease of $4,792,793. There was a decrease in the value of the production of recoverable zinc from $2,275,402 in 1917 to $1,521,953 in 1918. Silver decreased in quantity but increased in value from $9,286,454 in 1917 to $10,000,599 in 1918, owing to the higher price. The production of gold from all sources in 1918 was valued at $6,619,937, against $6,959,468 in 1917, a decrease of $339,531, or nearly 5 per cent. The gold from placer mines decreased from $292,584 in 1917 to $218,380 in 1918. Thirteen mining companies in Nevada, some of which owned property in other States, paid dividends in 1918 amounting to $8,795,774.

Mine production of gold, silver, copper, lead, and zinc in Nevada in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[b]	Silver.[b]	Copper.	Lead.	Recoverable zinc.	Total value.[b]
		Short tons.		*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	943	6,473,519	$6,959,468	11,269,969	122,794,704	27,677,928	22,307,868	$54,424,580
1918	714	6,472,579	6,619,937	10,000,599	116,316,441	23,316,534	16,724,753	48,528,124
Decrease, 1918		940	339,531	1,269,370	6,478,263	4,361,394	5,583,115	5,896,456
Total, 1904–1918		52,831,476	168,158,077	166,240,985	860,185,312	184,925,801	152,712,325	459,621,342

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[a] The statistical tables of this report were compiled by Bessie N. Patchell, of the United States Geological Survey.

[b] Includes placer production.

ORE.

Mines in Nevada produced 6,472,579 short tons of ore in 1918, a decrease of 940 tons, compared with the production of 1917. The average total metallic value per ton was $7.46, against $8.36 in 1917, but the value per ton in gold and silver increased from $2.46 in 1917 to $2.53 in 1918. The largest decrease in production of ore was in Mineral, Esmeralda, Lincoln, Clark, and Churchill counties. The output of dry or siliceous ores decreased from 1,413,929 tons in 1917 to 1,394,583 tons in 1918. Under this classification for 1918 are included 540,320 tons of low-grade siliceous gold ores, averaging $6.42 in gold and 1.05 ounces of silver per ton, and carrying small quantities of copper and lead. Gold and silver mixed ores, dry or siliceous in character, aggregated 14,384 tons and averaged per ton $4.54 in gold and 4.02 ounces of silver. Some of these ores contained a small quantity of copper and lead. The output of siliceous silver ores in 1918 amounted to 839,879 tons, mined by 161 producers, averaging per ton $2.12 in gold and 10.15 ounces of silver, as against 807,087 tons mined in 1917 by 130 producers, whose ore averaged per ton $2.40 in gold and 11.83 ounces of silver. A total of 89,853 tons of oxidized iron-manganese ore, which was produced entirely in the vicinity of Pioche, is included in the silver ore. This ore contained lead and small quantities of gold and silver and was particularly valuable as flux.

The production of copper ore by 137 operators amounted to 4,994,804 tons and contained 49,186.44 ounces of gold, 278,615 ounces of silver, 116,109,020 pounds of copper, and 69,172 pounds of lead, the value per ton averaging $6. The output of lead ores decreased from 66,614 tons in 1917 to 48,169 tons in 1918. Lead ore of smelting grade amounted to 23,305 tons. In this smelting ore the oxidized ore, largely carbonates, decreased in quantity from 26,260 tons in 1917 to 17,874 tons in 1918 and averaged $1.73 in gold, 12.63 ounces of silver, 2.37 pounds of copper, 422.15 pounds of lead, and $44.92 in total value per ton. The smelting sulphide ores of lead amounted to 5,431 tons and averaged $1.89 in gold, 20.69 ounces of silver, 4.24 pounds of copper, 572.31 pounds of lead, and $64.26 in total value per ton. Zinc ores of shipping grade decreased from 18,393 tons in 1917 to 10,977 tons in 1918, were nearly all oxidized or carbonate ores, and averaged 624.68 pounds of recoverable zinc per ton. Production of copper-lead ores decreased from 1,158 tons in 1917 to 800 tons in 1918, all of which was shipped to smelters. Most of the first-class ore, 791 tons in quantity, was oxidized or carbonate copper-lead ores, averaging $22.34 in gold, 15.28 ounces of silver, 78.74 pounds of copper, 300.72 pounds of lead, and having a total value per ton of $78.42. There were 23,246 tons of lead-zinc ore produced, more than half of which, or 12,028 tons, was concentrated into 2,686 tons of lead concentrate and 6,894 tons of zinc concentrate. The remainder—11,218 tons—was lead-zinc ore of shipping grade, all of which was oxidized.

The output of milling ores was 5,603,436 tons, of which 1,042,874 tons were treated either by amalgamation or cyanidation, and the remainder, 4,560,562 tons, by concentration, followed by smelting. The ore and tailings treated by cyanidation—988,826 tons of the former and 232,053 tons of the latter—contained an average per ton of $3.64 in gold and 6.62 ounces of silver. The ores amalgamated, 54,048 tons, yielded bullion averaging per ton $8.44 in gold and 0.32 ounce of silver.

Mine production of gold, silver, copper, lead, and zinc in Nevada in 1918.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	54	....	10,564.13	3,907	....	....	....
Dry or siliceous ore	373	1,394,583	257,063.06	9,152,376	70,634	5,516,226	....
Copper ore	137	4,994,804	49,186.44	278,615	116,109,020	69,172	....
Lead ore	168	48,169	2,311.40	429,917	69,838	12,972,922	....
Zinc ore	23	10,977	29.56	10,845	....	111,015	6,857,164
Copper-lead ore	18	800	929.14	12,218	63,410	241,583	....
Lead-zinc ore	10	23,246	155.72	112,721	3,539	4,405,616	9,867,589
	....	6,472,579	320,239.45	10,000,599	116,316,441	23,316,534	16,724,753

Ore sold or treated in Nevada in 1918, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Churchill	49,899	7	44	....	....	....	49,950
Clark	16,128	1,843	10,690	9,316	239	19,418	57,634
Douglas	35	22	....	....	....	....	57
Elko	48,060	1,292	1,254	36	156	....	50,798
Esmeralda	258,914	34,361	475	....	4	....	293,754
Eureka	2,882	67	1,987	....	....	....	4,936
Humboldt	116,898	1,537	902	....	6	....	119,343
Lander	7,798	17,137	491	....	6	....	25,432
Lincoln	89,857	5,745	14,785	786	....	3,828	115,001
Lyon	15,726	398,561	....	....	....	....	414,287
Mineral	141,129	15,560	431	....	15	....	157,135
Nye	550,262	5	1,802	....	12	....	552,081
Ormsby	367	....	....	....	....	....	367
Storey	95,051	....	....	....	....	....	95,051
Washoe	563	36	1,492	....	....	....	2,091
White Pine	1,014	4,518,631	13,816	839	362	....	4,534,662
	[a]1,394,583	4,994,804	48,169	10,977	800	23,246	6,472,579
Average value per ton in gold and silver	$10.37	$0.26	$9.92	$1.04	$39.28	$4.99	$2.53

[a] Includes 540,320 tons of gold ore, 14,384 tons of gold and silver ore, and 839,879 tons of silver ore. The last named includes 89,853 tons of oxidized iron-manganese ore.

GOLD.

The mine production of gold in Nevada was valued at $6,619,937 in 1918, a decrease of $339,531 as compared with 1917. Nye County is credited with the largest production of gold, amounting to $1,991,845, against $2,007,234 in 1917. Esmeralda County followed with a production of $1,361,321, against $1,986,001 in 1917. Goldfield district, which produced $687,510 less than in 1917, is credited with most of this output. The counties whose gold output showed largest increases were Elko, Storey, Lander, and Lyon. The largest decreases were in Esmeralda, Mineral, White Pine, and Churchill counties. Placer gold was produced in greatest quantity in Nye, Lander, and Eureka counties, the value of the total placer gold being $218,380, as against $292,584 in 1917. Ore was milled in 1918 by amalgamation in 14 counties and by cyanidation in 12 counties. From these two methods of treatment $4,911,139 in gold was produced from 1,042,874 tons of ore and 232,053 tons of old tailings.

The total average recovery of gold from ore and tailings milled was $3.85 a ton. The gold extracted by amalgamation averaged $8.44 a ton of ore treated, as against $6.67 a ton in 1917, and by cyanidation it averaged $3.64 a ton of ore and tailings treated, as against $3.87 in 1917. From all concentrates, including siliceous, copper, lead, lead-zinc, and iron sulphide concentrates, 46,155.31 ounces of gold were produced, against 50,465.61 ounces in 1917. The gold in dry or siliceous concentrates was 1,552.96 ounces in 1918, against 4,057.75 ounces in 1917 and 13,235.26 ounces in 1916. In each of these years the production of gold was principally from iron sulphide concentrates. The copper concentrates contained 43,580.87 ounces, against 46,030.84 ounces in 1917, and the lead concentrates 1,021.48 ounces, against 327.76 ounces in 1917.

Sixteen producers furnished nearly three-fourths of the total gold in 1918. These properties, which yielded more than 6,000 ounces each, were the Goldfield Consolidated, with 46,173.19 ounces, followed by the Nevada Consolidated Copper mine, at Ely; the Elkoro mine, at Jarbidge; Tonopah Mining, at Tonopah; Aurora Consolidated, at Aurora; Tonopah Belmont, at Tonopah; Elko Prince, at Midas; Tonopah Extension, at Tonopah; White Caps, at Manhattan; Olympic, in Mineral County; Union Consolidated, at Virginia City; West End, at Tonopah; Fairview Round Mountain, at Round Mountain; Rochester Mines, in Humboldt County; Florence mine, at Goldfield; and Round Mountain Mining Co., at Round Mountain.

Placer mining is reported to have received more attention in 1918 than in many years, according to a recently published article,[1] from which extracts follow:

> A dozen or more districts in the State yielded placer gold in the early-day operations, conducted in many instances by Chinese miners; but the lack of water has long been supposed to preclude successful placer mining. The only important operation of this character in late years has been that of the Round Mountain Mining Co., in northern Nye County. In recent months, Goldfield men have been prospecting the bed and tributary gulches of Tule Canyon, an offshoot of Death Valley, in southern Esmeralda County, and have found rich gravel above shallow bedrock at many points for a distance of 5 miles along the bed of the canyon. Several districts in Humboldt County produced placer gold in large quantity, including American Canyon, near the present town of Rochester; Rabbit Hole basin, 30 miles north of Lovelock; Horse Creek canyon, at the northern extremity of the county; Dry Canyon and Spring Valley, south of Mill City; Barber Canyon and Dun Glen, east of Mill City. It is said Wells Fargo & Co.'s receipts show that Chinese miners shipped $12,000,000 in gold from Barber Canyon in eight years. In Elko County, the Tuscarora district, on the border of Independence Valley, and the Bull Run placers, farther north, sent out quantities of gold. Rich gravel has been found in the region drained by the Little Salmon River, in the far northern part of Elko County, and in Squaw Valley, west of Tuscarora. Nye County, in addition to the Round Mountain placers, contains ground that was worked profitably many years ago and within recent months gold was being taken from placers near Ione and in Golden Canyon, near Smokey Valley. In Lander County, the Copper Canyon placer mine is now being worked successfully, and a placer boom some three years ago resulted in founding the camp of Bannock, now nearly deserted. Esmeralda County has many promising fields for placer mining in addition to the Tule Canyon region. Chinese and white miners produced gold from placers at Klondyke, midway between Goldfield and Tonopah, some 40 years ago, and their workings are still to be seen. Gold nuggets, one valued at $1,200, have been found here in late years. Gold Mountain, Fish Lake Valley, and the Lida districts are said to contain placer ground of great value. Of course, the Manhattan gravels must not be forgotten. Dry washing has been successful only under certain favorable conditions, but nowhere in Nevada has the problem of recovering placer gold been attacked seriously or with equipment other than that available to the prospector.

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[1] Min. and Sci. Press, vol. 117, p. 569, Oct. 26, 1918.

Mine production of gold in Nevada in 1918, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	
Churchill		4,969.06		1.03				4,970.09
Clark		6,583.69	746.85	159.40		902.01		8,391.95
Douglas	4.55	29.46						34.01
Elko	16.69	31,075.51	522.76	9.38		.72		31,625.06
Esmeralda		52,248.81	13,544.98	60.11				65,853.90
Eureka	80.30	797.52	26.63	824.62				1,729.07
Humboldt	44.94	12,068.70	9.03	59.23		.13		12,182.03
Lander	3,690.00	2,598.20	1,142.86	133.29				7,564.35
Lincoln		256.36	89.63	590.40	29.56		155.72	1,121.67
Lyon		3,473.36	2.87					3,476.23
Mineral	47.55	27,693.03	107.61	147.45		9.86		28,005.50
Nye	6,680.10	89,461.72		213.42		.26		96,355.50
Ormsby		75.66						75.66
Storey		25,065.70						25,065.70
Washoe		545.71	14.73	1.63				562.07
White Pine		120.57	32,978.49	111.44		16.16		83,226.66
	10,564.13	[a]257,063.06	49,186.44	2,311.40	29.56	929.14	155.72	320,239.45

[a] Includes 167,878.58 ounces from gold ore, 3,157.77 ounces from gold and silver ore, and 86,026.71 ounces from silver ore.

SILVER.

The mine production of silver in Nevada in 1918 was 10,000,599 ounces, valued at $10,000,599, a decrease of 1,269,370 ounces in quantity but an increase of $714,145 in value, as compared with the output of 1917. Nye County was again the largest producer, with 6,104,711 ounces, against 7,172,642 ounces in 1917; and Humboldt County produced 869,662 ounces, against 859,837 ounces in 1917. Churchill County produced the third largest quantity of silver in 1918, or 625,152 ounces, against 887,765 ounces in 1917. Milling plants using amalgamation and cyanidation in the extraction of the precious metals produced 8,096,148 ounces of silver, of which 17,459 ounces were recovered by amalgamation and 8,078,689 ounces by cyanidation. Nye County was credited with the largest production of silver by cyanidation—5,792,685 ounces—from ores treated principally in the Tonopah district. In Humboldt County, principally in the Rochester district, 748,875 ounces of silver were recovered by cyanidation. Concentrates from milling plants yielded 509,928 ounces of silver, against 713,459 ounces in 1917. Siliceous concentrates contained 191,632 ounces, against 309,160 ounces in 1917; copper concentrates produced 116,834 ounces, against 150,950 ounces in 1917. Lead concentrates contained 180,372 ounces of silver, or an average per ton of 32.71 ounces, against 191,989 ounces, or an average per ton of 27.89 ounces, in 1917. Zinc concentrates contained 21,090 ounces, or an average per ton of 3.06 ounces.

About 59 per cent of the total silver was produced in 1918 from six mines, as follows: The Tonopah Mining Co., Belmont, Tonopah Extension, and West End, all at Tonopah; the Nevada Wonder, in Churchill County; and the Rochester mine, in Humboldt County.

Mine production of silver in Nevada in 1918, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	
Churchill		619,230	133	5,789				625,152
Clark		108,816	6,469	39,987	6,200	1,474	89,748	252,694
Douglas	1	133	7					141
Elko	6	195,101	4,087	28,332		2,558		230,084
Esmeralda		267,497	39,552	15,562		79		322,690
Eureka	7	18,396	366	48,208				66,977
Humboldt	16	852,254	3,222	14,011		159		869,662
Lander	490	98,364	35,935	29,247		233		164,269
Lincoln		231,731	48,177	113,784	4,645		22,973	421,310
Lyon		52,272	170					52,442
Mineral	48	291,632	42,273	16,654		1,153		351,760
Nye	3,339	6,064,835	61	36,326		150		6,104,711
Ormsby		2,356						2,356
Storey		321,636						321,636
Washoe		1,597	514	23,394				25,505
White Pine		26,526	97,649	58,623		6,412		189,210
	3,907	[a] 9,152,376	278,615	429,917	10,845	12,218	112,721	10,000,599

[a] Includes 569,406 ounces from gold ore, 57,785 ounces from gold and silver ore, and 8,525,185 ounces from silver ore.

COPPER.

In 1918 the mines of Nevada produced 116,316,441 pounds of copper, valued at $28,730,161, a decrease of 6,478,263 pounds in quantity and of $4,792,793 in value. The Nevada Consolidated mines and the Consolidated Coppermines Co., at Ely, in White Pine County, were the largest producers of copper, followed by the mines in the Yerington district of Lyon County. White Pine County mines produced 92,538,218 pounds in 1918, against 93,786,328 pounds in 1917; Lyon County mines, 17,138,747 pounds, against 19,397,002 pounds in 1917; Lander County mines, 2,261,246 pounds, against 2,480,602 pounds; Mineral County mines, 2,228,337 pounds, against 3,461,969 pounds; and Esmeralda County mines, 551,987 pounds, against 762,627 pounds. Concentrates recovered at milling plants contained 85,860,578 pounds of copper, against 86,901,725 pounds in 1917. Of the output in 1918, copper concentrates contained 85,854,958 pounds, against 86,896,898 pounds in 1917. Crude ore shipped to smelters contained 30,356,382 pounds of copper, against 35,565,796 pounds in 1917. The crude copper ores smelted contained 30,209,685 pounds, of which 8,395,141 pounds were produced from sulphide ores and 21,814,544 pounds from oxidized ores. Lead ores of smelting grade produced 65,426 pounds of copper—23,014 pounds from sulphide ores and 42,412 pounds from oxidized ores. Copper-lead ores shipped, nearly all of which were oxidized, contained 241,583 pounds of copper.

Seven mines produced 96 per cent of the total copper in 1918. The Nevada Consolidated and the Consolidated Coppermines, near Ely, had the greatest output, followed by the Blue Stone, Mason Valley, and Nevada Douglas mines, in the Yerington district of Lyon County; the Wall Street property, in Mineral County; and the Copper Canyon mine, in Lander County.

Mine production of copper in Nevada in 1918, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Churchill		1,336	99			1,435
Clark	132	440,990	11,771	14,593		467,486
Douglas		3,008				3,008
Elko		323,214	6,795	13,932		343,941
Esmeralda	7,094	542,609	1,890	394		551,987
Eureka	52,105	12,764	2,749			67,618
Humboldt	475	246,383	945	1,468		249,271
Lander	460	2,258,491	1,989	306		2,261,246
Lincoln	792	413,618	21,818		3,539	439,767
Lyon		17,138,747				17,138,747
Mineral	4,167	2,219,582	1,180	3,408		2,228,337
Nye	5,045	258	2,332	905		8,540
Ormsby	364					364
Washoe		16,476				16,476
White Pine		92,491,544	18,270	28,404		92,538,218
	[a] 70,634	116,109,020	69,838	63,410	3,539	116,316,441

[a] Includes 6,944 pounds from gold ore, 52,105 pounds from gold and silver ore, and 11,585 pounds from silver ore.

LEAD.

The mine production of lead in Nevada in 1918 was 23,316,534 pounds, valued at $1,655,474, against 27,677,928 pounds, valued at $2,380,302, in 1917, a decrease in 1918 of 4,361,394 pounds in quantity and $724,828 in value. Lincoln County mines continued to have the largest output, 8,893,658 pounds, in 1918, followed by Clark County mines, with 6,541,129 pounds, and by White Pine County mines, with 4,573,941 pounds. More than 18 per cent of the output of lead was derived from the concentrates of milling ores and nearly 80 per cent from crude ore shipped directly to smelters. Lead concentrates (carbonates and sulphides) shipped to smelters contained 4,072,281 pounds of lead, against 5,865,304 pounds in 1917, and averaged 36.92 per cent of lead in 1918, against 42.60 per cent in 1917. Zinc concentrates shipped in 1918 contained 318,352 pounds of lead and averaged 2.31 per cent. The total crude ore of shipping grade contained 18,628,912 pounds of lead, against 20,068,411 pounds in 1917. The iron-manganese ores, classified under dry or siliceous ores, contained 5,384,642 pounds of lead. Oxidized lead ore shipped to smelters contained 7,545,496 pounds of lead and sulphide ore 3,108,327 pounds against 9,213,315 pounds and 3,239,963 pounds, respectively, in 1917. Zinc ores shipped produced 111,015 pounds of lead, nearly all of which was from oxidized ores. Copper-lead ores of shipping grade, mostly oxidized, produced 241,583 pounds of lead. The oxidized lead-zinc ores of smelting grade produced 2,143,293 pounds of lead.

About 72 per cent of the lead was from seven mines and the remainder from numerous properties. The leading producer was the Prince Consolidated mine, near Pioche, Lincoln County, followed by the Yellow Pine mine, in Clark County; the Ward mine, in White Pine County; the Groom mine and Combined Metals mine, in Lincoln County; the Anchor mine, in the Yellowpine district of Clark County; and the Eureka Holly mine, in Eureka County.

Mine production of lead in Nevada in 1918, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Churchill	3,716	602	34,772				39,090
Clark	3,619		2,582,345	70,069	46,913	3,838,183	6,541,129
Elko	7,094		651,893		29,002		687,989
Esmeralda	19,252		137,111		2,220		158,583
Eureka	94,872		1,102,420				1,197,292
Humboldt	523		252,930		1,733		255,186
Lander	1,003	928	221,618		4,422		227,971
Lincoln	5,384,642	64,038	2,836,599	40,946		567,433	8,893,658
Mineral	978		166,250		4,432		171,660
Nye	447		461,194		3,271		464,912
Washoe			105,123				105,123
White Pine	80	3,604	4,420,667		149,590		4,573,941
	[a] 5,516,226	69,172	12,972,922	111,015	241,583	4,405,616	23,316,534

[a] Includes 10,089 pounds from gold ore, 94,616 pounds from gold and silver ore, and 5,411,521 pounds from silver ore.

ZINC.

The mine production of recoverable zinc from zinc and lead-zinc ores mined in Nevada in 1918 is calculated as 16,724,753 pounds, valued at $1,521,953, against 22,307,868 pounds, valued at $2,275,402, in 1917. Clark County is credited with the largest part of the output, or 15,472,155 pounds of zinc, most of which came from the Yellow Pine district, followed by Ely, in White Pine County, and the Pioche district, in Lincoln County. There was also a small quantity produced in Elko County. Zinc concentrates recovered at milling plants amounted to 6,894 tons and averaged 29.26 per cent of zinc. The shipments of crude zinc ore amounted to 10,977 tons, nearly all oxidized or carbonate ores, and averaged 31.24 per cent of recoverable zinc. The lead-zinc ore, mostly oxidized, was from the Yellow Pine district of Clark County and averaged 26 per cent of recoverable zinc and some lead, being of particular value to the oxide plants in the Eastern States.

Nearly 91 per cent of the total zinc was from ores from six mines, the Yellow Pine, Potosi, Green Monster, and Ingomar, all in Clark County; the Consolidated Coppermines Co., at Ely, in White Pine County; and the Amalgamated Pioche mines, in Lincoln County.

Mine production of recoverable zinc in Nevada in 1918, in pounds.

County.	Zinc ore.	Lead zinc ore.	Total.
Clark	5,854,363	9,617,792	15,472,155
Elko	17,995		17,995
Lincoln	331,921	249,797	581,718
White Pine	652,885		652,885
	6,857,164	9,867,589	16,724,753

Zinc-producing ores and concentrates from Nevada mines sold in 1918.

Classification.	County.	Quantity.	Average zinc assay of ore and concentrate.[a]
		Short tons.	*Per cent.*
Sulphide zinc ore	Lincoln	[b] 764	24.42
Oxidized zinc ore	Clark, Elko, Lincoln, and White Pine	10,213	37.66
Oxidized lead-zinc ore	Clark	11,218	30.59
Zinc concentrates	Clark and Lincoln	6,894	34.44
		29,089	33.82

[a] Actual assay content. [b] Ore contained a small percentage of lead sold to an oxide plant in Colorado.

NEVADA MINING INDUSTRY, 1918.

Higher cost and lower efficiency of labor, increased freight rates, and higher cost of mining supplies affected the mining industry and reduced the earnings of many Nevada mines producing ore in 1918. Mining costs in Nevada are peculiarly illuminating in that they represent conditions unlike those pertaining to other Western States, with the possible exception of Arizona. Practically all supplies must be brought in from considerable distances and at comparatively high freight rates. Machinery and labor are also brought from distant centers. Water must be developed at high cost. Living conditions are not particularly attractive. The mines are deep, and a large proportion of development work is necessary. Many of the ore bodies are of small extent. Ore treatment requires excessively fine grinding. Only in the power cost does the Tonopah district appear to have any advantage, and this is due to fortuitous circumstances. A recently published article[1] reviews this condition in detail, giving some of the mining costs in 1913 compared with the costs in 1917.

At the end of 1918 the mining industry in Nevada was in a sadly demoralized condition. The collapse of the copper market found prospectors and the mining companies having ore in transit with no recourse but to accept the terms of the ore buyer, who in turn was unable to pay in full for the copper owing to the absence of quotations. A preliminary settlement was made for copper on the basis of 11 cents a pound, the remaining payment to be made on the establishment of a market.

Eureka, one of the richest of Nevada's bonanza camps, gives promise of a revival under development that is being conducted for the purpose of reopening the old mines. The reopening of the lower levels of the Comstock lode is an interesting event in the mining history of the West and is partly reviewed in the section on Storey County in this report.

Ores of various kinds were milled at 76 plants, against 79 plants in 1917. Many of these plants were operated for only short periods each year. Twenty-six plants used the amalgamation process, against 20 in 1917; 2, both amalgamation and table concentration, against 8 in 1917; 5, amalgamation and cyanidation, against 1 in

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[1] Carpenter, J. A., Effect of the war upon Tonopah mining: Eng. and Min. Jour., vol. 106, p. 601, Oct. 5, 1918.

1917; and 1 used amalgamation, table concentration, and cyanidation. Fourteen plants, against 18 in 1917, used concentration, of which 4 were equipped with the oil flotation process in conjunction with the tables, and 1 was equipped for oil flotation only. Twenty-four straight cyanidation mills were operated in 1918, against 25 in 1917; and 3 mills used cyanidation and concentration, against 3 in 1917. At one plant, in Lyon County, experimental work with the the leaching process was done.

During 1918 about 675 pounds (partly estimated) of quicksilver was consumed at amalgamation mills. At cyanide mills 1,765,010 pounds of sodium cyanide were used. There was a consumption of 0.017 pound of mercury per ounce of gold and silver bullion produced, and of 0.012 pound of mercury per ton of ore treated; the consumption of cyanide was 0.21 pound per ounce of gold and silver bullion produced and 1.45 pounds per ton of ore and tailings treated. The total value of bullion recovered from ore and tailings was $13,007,287, against $12,742,830 in 1917.

Gold and silver produced from Nevada mills in 1918.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Churchill	[a] 49,724	7.95	2	4,620.05	557,938	$653,609
Clark	[b] 15,975	852.26	1,222	5,287.64	98,653	226,798
Douglas	35	29.46	23		110	742
Elko	47,317	168.12	135	[c] 30,203.98	[c] 173,829	801,811
Esmeralda	88,192	66.95	13	[d] 41,247.73	[d] 219,351	1,073,414
Eureka	442	114.65	26			2,396
Humboldt	[e] 110,453	2,056.57	2,857	[f] 8,364.74	[f] 748,875	967,160
Lander	5,028	46.62	34	[g] 1,825.00	[g] 2,680	41,404
Lyon	11,821	1,389.64	1,602	[h] 1,880.71	[h] 34,930	104,137
Mineral	121,278	25.19	23	[i] 26,699.52	[i] 138,896	691,368
Nye	[j] 531,799	14,518.77	7,835	[k] 73,088.81	[k] 5,792,685	7,611,529
Ormsby				[l] 71.64	[l] 694	2,175
Storey	[m] 60,154	2,194.92	2,227	[n] 22,210.27	[n] 310,048	816,775
Washoe	553	519.54	1,399			12,139
White Pine	103	85.59	61			1,830
	1,042,874	22,076.23	17,450	215,500.09	8,078,689	13,007,287

[a] Also yielded 89 tons of concentrates.
[b] Also yielded 12 tons of concentrates.
[c] Includes bullion from 350 tons of old tailings.
[d] Includes bullion from 164,121 tons of old tailings.
[e] Also yielded 5 tons of concentrates.
[f] Includes bullion from 835 tons of old tailings.
[g] Includes bullion from 500 tons of old tailings.
[h] Includes bullion from 2,730 tons of old tailings.
[i] Includes bullion from 13,265 tons of old tailings.
[j] Also yielded 303 tons of concentrates.
[k] Includes bullion from 15,137 tons of old tailings.
[l] Bullion from 330 tons of old tailings.
[m] Also yielded 123 tons of concentrates.
[n] Includes bullion from 34,785 tons of old tailings.

Mills equipped for the concentration of low-grade ore treated 4,560,562 tons, or nearly 70 per cent of the total ore sold or treated. The concentrates aggregated 544,061 tons and contained $954,115 in gold, 509,928 ounces of silver, 85,860,578 pounds of copper, 4,390,633 pounds of lead, and 4,034,123 pounds of recoverable zinc, valued in all at $23,350,446, or a total average value per ton of $42.92.

Mine production of gold, silver, copper, lead, and zinc from Nevada concentrates in 1918.

By counties.

County.	Ore to concentrating mills.	Concentrates.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value of concentrates.
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Churchill		89	259.00	43,741				$49,095
Clark	16,916	8,831	156.00	113,633	119	2,755,606	3,784,326	656,909
Esmeralda	33,507	5,766	11,562.09	31,118	432,125	51,800		380,541
Humboldt		5	22.25	651				1,111
Lincoln	3,828	2,736	365.59	49,725	3,539	1,071,642	249,797	156,973
Lyon	59,749	3,895			1,967,092			485,872
Nye	2,500	786	779.71	149,057		116,000		173,411
Storey		128	527.00	5,868				16,762
Washoe	1,492	213	1.63	23,394		105,123		30,892
White Pine	4,442,570	521,612	32,482.04	92,741	83,457,703	290,462		21,398,880
	4,560,562	544,061	46,155.31	509,928	85,860,578	4,390,633	4,034,123	23,350,446

By kinds of concentrates.

	Concentrates.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value of concentrates.
Dry or siliceous	810	1,552.96	191,632				$223,734
Copper	530,843	43,580.87	116,834	85,854,958			22,223,906
Lead	5,514	1,021.48	180,372	5,620	4,072,281		492,008
Zinc	6,894		21,090		318,352	4,034,123	410,798

All the higher-grade ores were shipped crude to the smelters, the copper ores in greatest quantity and in value. There were 623,828 tons of ore smelted in 1918, as compared with 658,447 tons in 1917. The output of smelting ores by counties follows:

Mine production of gold, silver, copper, lead, and zinc from Nevada crude ore shipped to smelters in 1918.

By counties.

County.	Quantity.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Churchill	226	83.09	23,471	1,435	39,090		$28,318
Clark	24,743	2,096.05	39,186	467,367	3,785,523	11,687,829	1,530,319
Douglas	22		7	3,008			750
Elko	3,131	1,236.27	56,114	343,941	687,989	17,995	217,107
Esmeralda	7,934	12,977.13	72,208	101,849	106,783		373,209
Eureka	2,643	1,140.35	61,899	15,759	1,101,336		167,559
Humboldt	7,253	1,598.45	100,079	248,700	95,596		201,338
Lander	19,904	2,002.73	161,065	2,261,246	227,971		777,179
Lincoln	101,173	756.08	371,585	436,228	7,822,016	831,921	1,080,530
Lyon	339,884	205.88	15,910	15,165,506			3,766,046
Mineral	22,592	1,233.24	212,793	2,228,337	171,660		800,873
Nye	2,645	1,288.11	151,795	8,540	348,912		205,305
Ormsby	37	4.02	1,662	364			1,835
Storey	77	133.51	3,493				6,253
Washoe	46	40.90	712	16,476			5,627
White Pine	91,518	643.59	93,624	9,057,626	4,242,036	652,885	2,704,760
	623,828	25,439.40	1,365,603	30,356,382	18,628,912	12,690,630	11,867,008

By kinds of ore.

	Quantity.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
Dry or siliceous	115,875	16,878.58	843,982	17,861	5,413,630		$1,581,672
Copper	461,653	5,605.47	159,900	30,209,685	65,568		7,742,223
Lead	23,305	1,996.63	338,128	65,426	10,653,828		1,151,985
Zinc	10,977	29.59	10,845		111,015	6,857,164	643,340
Copper-lead	800	929.13	12,218	63,410	241,583		64,239
Lead-zinc	11,218		530		2,143,293	5,833,466	683,549

PRODUCTION BY COUNTIES.

The subjoined tables are followed by a review of the mining industry for each county and each producing mining district.

Mine production of gold, silver, copper, lead, and zinc in Nevada in 1918.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.			
	Fine ounces.		*Fine ounces.*			*Fine ounces.*	
Churchill			4,970.09	$102,741	$102,741	625,152	$625,152
Clark			8,391.95	173,477	173,477	252,694	252,694
Douglas	4.55	$94	29.46	609	703	141	141
Elko	16.69	345	31,608.37	653,403	653,748	230,084	230,084
Esmeralda			65,853.90	1,361,321	1,361,321	322,690	322,690
Eureka	80.30	1,660	1,648.77	34,083	35,743	66,977	66,977
Humboldt	44.94	929	12,137.09	250,896	251,825	869,662	869,662
Lander	3,690.00	76,279	3,874.35	80,090	156,369	164,269	164,269
Lincoln			1,121.67	23,187	23,187	421,310	421,310
Lyon			3,476.23	71,860	71,860	52,442	52,442
Mineral	47.55	983	27,957.95	577,942	578,925	351,760	351,760
Nye	6,680.10	138,090	89,675.40	1,853,755	1,991,845	6,104,711	6,104,711
Ormsby			75.66	1,564	1,564	2,356	2,356
Storey			25,065.70	518,154	518,154	321,636	321,636
Washoe			562.07	11,619	11,619	25,505	25,505
White Pine			33,226.66	686,856	686,856	189,210	189,210
	10,564.13	218,380	309,675.32	6,401,557	6,619,937	10,000,599	10,000,599

County.	Copper.		Lead.		Recoverable zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Churchill	1,435	$354	39,090	$2,775			$731,022
Clark	467,486	115,469	6,541,129	464,420	15,472,155	$1,407,966	2,414,026
Douglas	3,008	743					1,587
Elko	343,941	84,953	687,989	48,847	17,995	1,638	1,019,270
Esmeralda	551,987	136,341	158,583	11,259			1,831,611
Eureka	67,618	16,702	1,197,292	85,008			204,430
Humboldt	249,271	61,570	255,186	18,118			1,201,175
Lander	2,261,246	558,528	227,971	16,186			895,352
Lincoln	439,767	108,622	8,893,658	631,450	581,718	52,936	1,237,505
Lyon	17,138,747	4,233,271					4,357,573
Mineral	2,228,337	550,399	171,660	12,188			1,493,272
Nye	8,540	2,109	464,912	33,009			8,131,674
Ormsby	364	90					4,010
Storey							839,790
Washoe	16,476	4,070	105,123	7,464			48,658
White Pine	92,538,218	22,856,940	4,573,941	324,750	652,885	59,413	24,117,169
	116,316,441	28,730,161	23,316,534	1,655,474	16,724,753	1,521,953	48,528,124

Production from deep mines in Nevada in 1917 and 1918.

County.	Ore sold or treated.		Number of deep mines producing.		Average value per ton.[a]		Average value per ton in gold and silver.[a]	
	1918.	Increase or decrease.	1917.	1918.	1917.	1918.	1917.	1918.
	Short tons.	*Short tons.*						
Churchill	49,950	− 10,637	13	13	$15.01	$14.63	$14.94	$14.57
Clark	57,634	− 82,416	106	61	40.38	41.88	5.36	7.39
Douglas	57	+ 34	4	3	52.52	26.17	24.35	13.14
Elko	50,798	+ 23,015	77	39	29.70	20.06	16.61	17.39
Esmeralda	293,754	− 55,901	61	55	6.76	6.23	6.05	5.73
Eureka	4,936	− 2,229	40	32	36.34	41.08	12.15	20.47
Humboldt	119,343	+ 14,779	100	92	11.03	10.06	9.12	9.39
Lander	25,432	+ 1,584	47	48	35.12	32.19	5.61	9.59
Lincoln	115,001	− 39,086	23	12	10.76	10.76	3.12	3.86
Lyon	414,287	+ 84,377	64	44	16.22	10.52	.17	.30
Mineral	157,135	−117,436	129	81	7.37	9.50	3.82	5.92
Nye	552,081	+ 37,720	79	79	15.04	14.47	14.96	14.41
Ormsby	367	+ 330	1	3	41.73	10.93	39.05	10.68
Storey	95,051	+ 35,246	33	29	9.38	8.83	9.38	8.83
Washoe	2,091	− 729	31	21	26.21	23.27	16.15	17.75
White Pine	4,534,662	+ 60,409	44	48	5.98	5.32	.21	.19
	6,472,579	− 940	852	660	8.36	7.46	2.46	2.53

[a] Value per ton, placer product excluded.

Production from placer mines in Nevada in 1917 and 1918.

County.	1917.					1918.				
	Mines.		Gold.	Silver.	Total value.	Mines.		Gold.	Silver.	Total value.
	Hydraulic.	Drift.				Hydraulic.	Drift.			
				Fine ounces.					*Fine ounces.*	
Douglas	1	......	$300	2	$302	1	......	$94	1	$95
Elko	3	......	606	8	613	5	......	345	6	351
Eureka	5	......	2,761	16	2,774	4	......	1,660	7	1,667
Humboldt	3	1	1,206	10	1,214	4	......	929	16	945
Lander	27	6	66,746	460	67,125	4	2	76,279	490	76,769
Lyon	......	1	74	2	76	......	......	......	......	......
Mineral	3	1	428	14	439	4	......	983	48	1,031
Nye	24	11	219,131	5,754	223,872	25	5	138,090	3,339	141,429
Washoe	2	......	120	2	122	......	......	......	......	......
White Pine	3	......	1,212	10	1,220	......	......	......	......	......
	71	20	292,584	6,278	297,757	47	7	218,380	3,907	222,287

CHURCHILL COUNTY.

Thirteen producers mined 49,950 tons of ore in 1918, against an output of 60,587 tons mined by the same number of producers in 1917. The total average value per ton decreased from $15.01 in 1917 to $14.63 in 1918. The larger part of the output was of milling grade and produced gold and silver bullion recovered by cyanidation of the ore. Some concentrate from a gold and silver mill was shipped directly to the smelters, as were also 226 tons of crude ore containing gold and silver, with some copper and lead.

Eagleville district.—The Golden Extension property produced a small quantity of crude ore containing gold and silver of shipping grade.

Fairview district.—Lessees on the Nevada Hills property produced gold and silver ore, which, with the production from three other properties, aggregated 54 tons, containing $795 in gold and 2,938 ounces of silver. Included was one lot of lead ore carrying silver.

Holy Cross district.—The Silver Star and one other property in the district yielded siliceous silver ore, which was shipped to the smelter.

Wonder district.—The principal producer of ore was the Nevada Wonder property. There was also a small output of ore from the Jack Pot property and the L. & N. claim. The Nevada Wonder mine[1] produced 49,710 tons of ore in 1918, averaging 0.103 ounce of gold and 13.23 ounces of silver per ton. This ore was treated by cyanidation and concentration and contained 5,108 ounces of gold and 657,815 ounces of silver, valued at $742,306.24, which gave a total net operating profit of $179,548.55, equivalent to $3.62 per ton. From the total gold and silver content of the ore thus treated there was recovered 4,877 ounces of gold and 601,665 ounces of silver, showing a recovery of 95.48 per cent of gold and 91.46 per cent of silver, a combined recovery of 91.82 per cent of the total. The gold extraction remained practically the same as for preceding years, being above 95 per cent; the silver extraction showed an increase over that of 1917 of 4.55 per cent, owing to the installation of four Senn concentrators. Referring to the cost of production an ounce of silver, the company report says:

> The cost of producing an ounce of silver in 1918 was $0.646. This cost per ounce is arrived at by considering gold as a by-product and taking the value of the gold produced from the total operating cost and dividing the result by the nnmber of ounces of silver produced.

Mining costs are compared for four years in the company's report which shows that the cost per ton of ore treated in 1918 was $4.48, against $5.41 per ton in 1917; the indirect costs per ton were $1.04 and 97 cents, and the total costs per ton were $5.52 and $6.38, respectively. The average cost of development per foot was $11.65 in 1918, against $11.05 in 1917. This compares with the cost in 1915 of $7.70 per foot.

Mining and milling costs and profits per ton of ore mined and milled, Nevada Wonder mine, 1914–1918.

	1914	1915	1916	1917	1918
Total mining cost per ton of ore, including transportation	$4.70	$4.19	$5.33	$6.43	$5.58
Total milling cost per ton of ore	3.37	2.81	3.31	4.12	4.26
Marketing cost per ton of ore	.28	.27	.26	.23	.25
Total cost per ton	8.35	7.27	8.90	10.78	10.09
Average value per ton of ore	15.52	13.97	15.40	16.55	14.93
Loss in tailings per ton of ore	1.06	.82	1.13	1.80	1.22
Recovery per ton of ore	14.46	13.15	14.27	14.75	13.71
Less total cost per ton	8.35	7.27	8.90	10.78	10.09
Profit per ton of ore mined and milled	6.11	5.88	5.37	3.97	3.62

Altogether the dividends paid Nevada Wonder stockholders since May 20, 1913, amounted to $1,478,581.75, of which $281,694.80 was paid in 1918.

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[1] Nevada Wonder Mining Co. Twelfth Ann. Rept., for year ending Dec. 31, 1918.

CLARK COUNTY.

Mine production in Clark County, Nev., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	106	90,050	$219,119	319,836	878,646	9,373,817	20,660,549	$3,636,058
1918	61	57,634	173,477	252,694	467,486	6,541,129	15,472,155	2,414,026
Decrease, 1918	....	32,416	45,642	67,142	411,160	2,832,688	5,188,394	1,222,032

In 1918, 57,634 tons of ore was produced by 61 operators. This was 32,416 tons less than was produced by 106 producers in 1917. The total average value per ton increased from $40.38 in 1917 to $41.88 in 1918, and the gold and silver value per ton in this ore increased from $5.36 to $7.39. Of the total ore, 24,743 tons was shipped directly to the smelters and produced $43,329 in gold, 39,186 ounces of silver, 467,367 pounds of copper, 3,785,523 pounds of lead, and 11,687,829 pounds of recoverable zinc, valued at $1,530,319, or an average value per ton of $61.85. There was 16,916 tons of ore treated by concentration or separation, which produced lead concentrates and zinc concentrates. The 8,831 tons of concentrates produced had a metal content of $3,225 in gold, 113,633 ounces of silver, 119 pounds of copper, 2,755,606 pounds of lead, and 3,784,326 pounds of recoverable zinc, valued in all at $656,909, or an average value per ton of $74.39. At gold and silver mills, 15,975 tons of ore was treated and produced $126,923 in gold and 99,875 ounces of silver.

Eldorado Canyon district.—Four producers reported 15,032 tons of ore, containing $112,143 in gold, 103,672 ounces of silver, 119 pounds of copper, and 3,430 pounds of lead, valued in all at $216,089, or an average value per ton of $14.38. Nearly all of this ore was milled, and yielded bullion principally by cyanidation. Most of the ore was mined from the Techatticup property. The Eldorado Flagstaff and the Rand properties also produced ore.

Gold Butte district.—Two small lots of oxidized copper ore containing silver were shipped from the Gold Butte district.

Las Vegas district.—The Johnny Stump property produced a small quantity of copper ore, which was shipped directly to the smelter.

Searchlight district.—Fourteen producers reported the mining of 1,700 tons of ore, containing $54,761 in gold, 8,395 ounces of silver, 44,477 pounds of copper, and 77,863 pounds of lead, valued in all at $79,670, or an average value per ton of $46.86. Of the output, 781 tons was shipped directly to the smelters and 919 tons was treated in milling plants which used principally amalgation and concentration processes. The Quartette mine, operated by lessees, was the the largest producer, followed by the Duplex property, which produced some gold bullion by amalgamation and some copper-lead ore of smelting grade. Most of the ore produced at the Cyrus Noble property was treated by amalgamation, and the gold bullion was shipped. There was also some siliceous gold and silver ore of smelting grade produced.

Sunset district.—Some gold bullion was recovered from ores produced at the Lucy Gray property.

Yellow Pine district.—Thirty-eight producers reported the output of 40,614 tons of ore, containing $4,869 in gold, 140,211 ounces of silver, 400,792 pounds of copper, 6,459,836 pounds of lead, and 15,444,731 pounds of zinc, valued in all at $2,108,193, or an average value per ton of $51.91. The ore shipped directly to the smelters amounted to 23,698 tons. Besides this 16,916 tons of ore was milled, producing largely zinc-lead concentrate. The principal producer was the Yellow Pine mine, followed by the Anchor property. Shipments of zinc and lead ore were also made from the Potosi, Sultan, and Ingomar properties. At the Yellow Pine property[1] ore was encountered on the ninth level of the Bybee mine, said to be a continuation of the large body on the seventh level from which most of the output in 1918 was mined. The shipments aggregated 19,366, tons of crude ore and concentrate, containing lead, silver, and zinc, which netted the company $524,746.91 free on board cars at Jean, Nev. Dividends amounting to $300,000 were distributed to stockholders during 1918.

DOUGLAS COUNTY.

Three producers reported the output of 57 tons of ore, of which 22 tons was shipped directly to the smelter and 35 tons was treated at gold and silver mills. The total value per ton of the ore was $26.17, and the gold and silver value was $13.14. The placer production amounted to $94 in gold and 1 ounce of silver.

Buckskin district.—The Minnesota-Nevada property, situated near Yerington, produced an oxidized copper ore.

Mount Siegel district.—There was a small output of bullion from the Ancient Gold placers.

Red Canyon district.—Siliceous ore was produced from the Longfellow property and treated in its milling plant equipped with a Lane mill, plates, classifiers, sand tables, Callow tank, and slime tables. The mill was only operated a few days, making tests on the ore.

Silver Glance district.—The Lucky Boy property produced a small quantity of gold and silver ore, treated in a custom mill at Silver City.

ELKO COUNTY.

Mine production in Elko County, Nev., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	80	27,783	$244,439	264,241	887,371	1,064,145	293,354	$825,864
1918	44	50,798	653,748	230,084	343,941	687,989	17,995	1,019,270
Increase or decrease, 1918	....	+23,015	+409,309	−34,157	−543,430	−376,156	−275,359	+193,406

[a] Includes placer production.

The output of ore reported by 39 deep-mine producers was 50,798 tons in 1918, which was 23,015 tons more than was produced by 77 operators in 1917. The total average value per ton of the ore decreased from $29.76 in 1917 to $20.06 in 1918, and the gold and silver value per ton increased from $16.61 to $17.39. A large part of the ore (47,317 tons) was treated at gold and silver mills and yielded bullion containing $627,847 in gold and 173,964 ounces of silver. The ore shipped was 3,131 tons, containing gold, silver, copper, lead, and zinc, valued at $217,107, or an average value per ton of $69.34. Placer operators reported the production of $345 in gold and 6 ounces of silver.

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[1] Yellow Pine Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

Charleston district.—A small lot of oxidized lead ore, containing silver, was shipped directly to the smelter from one property. A little bullion was also shipped, probably from placer operations.

Contact district.—There was 555 tons of ore produced in 1918, containing $234 in gold, 431 ounces of silver, and 198,222 pounds of copper, valued in all at $49,626, or an average value per ton of $89.42. Most of the ore was oxidized in character and was shipped from the Bellevue property. There was also some ore produced from the Green monster, Palo Alto, and Valley View properties.

Delno district.—Three producers reported the output of 569 tons of ore, containing $22 in gold, 15,422 ounces of silver, 376 pounds of copper, and 318,709 pounds of lead, valued in all at $38,165, or an average value per ton of $67.06. The Net No. 2 mine produced the largest quantity of ore. There were also shipments from the Gold Bond property.

Divide district.—Lessees produced from the Divide property a small quantity of silver ore, containing a little gold.

Dolly Varden district.—Oxidized lead ore of smelting grade was produced from two properties in the Dolly Varden district.

Gold Circle district.—Six producers reported the output of 18,692 tons of ore, containing $288,591 in gold and 167,684 ounces of silver, valued in all at $456,275, or an average value per ton of $24.42. Only 158 tons of the total ore produced was shipped directly to the smelters. The principal part of the output came from the Elko Prince mine, which operated its cyanidation plant the greater part of the year. A full description of this property was given in the report[1] on Nevada for 1917.

Island Mountain (Gold Creek) district.—A quantity of old tailing was treated by cyanidation in the Island Mountain district and yielded bullion containing gold and silver.

Jarbidge district.—The Long Hike property of the Elkoro Mines Co. was the principal producer of ore, which was treated in its 100-ton cyanidation plant. Mining and milling operations were commenced in March. It is reported that development work is being done on three other properties, the Starlight, O. K., and North Star. These mines are being equipped with tramways and actual production will probably commence the latter part of 1919. During 1918 a 72-mile transmission line carrying 66,000 volts was completed into the camp, thus furnishing sufficient power for the mill and active development work in the mines. A small quantity of gold, probably recovered from surface placers, was reported in 1918.

Lee district.—Four producers shipped to the smelters 82 tons of ore, containing $27 in gold, 1,342 ounces of silver, and 51,708 pounds of lead, valued in all at $5,040, or an average value per ton of $61.46.

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[1] U. S. Geol. Survey Mineral Resources, 1917, pt. 1, pp. 270, 271, 1919.

The producers were the American Beauty and B. & B. claims and two other properties.

Lone Mountain district.—The Rip Van Winkle property produced in 1918 a small quantity of oxidized lead ore, containing silver.

Merrimac district.—A small quantity of oxidized lead ore was mined from the Elfreda claim and shipped to the smelter.

Railroad district.—Six producers reported the output of 613 tons of ore, containing $196 in gold, 12,605 ounces of silver, 72,165 pounds of copper, and 128,250 pounds of lead, valued in all at $39,732, or an average value per ton of $64.80. All this ore was of shipping grade. The principal part of it came from the Bunker Hill property, which yielded largely oxidized lead ore. Some copper ore, containing silver was produced from the Gray Eagle property. During 1918 the main tunnel of the Bunker Hill property [1] was driven a distance of 740 feet. This makes the face of the adit 3,410 feet from its portal. At the 3,000-foot point in the adit a porphyry dike 6 feet wide was cut, which showed carbonates of copper across its entire width. At 3,035 feet 6 feet of garnet lime was cut, sampling 2 per cent of copper and 6 ounces of silver to the ton. Lessees shipped 27.5 dry tons of ore from the Grant claim in 1918, averaging 36 ounces of silver per ton, 11.4 per cent of lead, and 6.4 per cent of copper, giving net returns of $1,395.75. From the Tripoli claim 258.9 dry tons of ore contained 56 ounces of silver per ton, 25.7 per cent of lead, and 1 per cent of copper, yielding net returns of $10,421.54.

Spruce Mountain district.—Three producers reported 480 tons of ore, containing $55 in gold, 12,454 ounces of silver, 19,929 pounds of copper, and 89,265 pounds of lead, valued in all at $23,769, or an average value per ton of $49.52. The Bullshead and Black Forest properties were the principal producers.

Tacoma district.—Oxidized lead ore from the Jackson group was shipped by lessees to the smelters near Salt Lake.

Tuscarora district.—Some gold bullion, containing silver and resulting from the treatment of ore and old tailings by amalgamation, was reported by two producers. One small lot of placer gold was reported by a dealer as purchased from one operator in the district.

Van Duser district.—A small quantity of placer gold was reported from one property in the Van Duser district.

Warm Creek district.—From the Polar Star property a small lot of oxidized zinc ore was shipped to the sampler near Salt Lake.

ESMERALDA COUNTY.

Mine production in Esmeralda County, Nev., in 1917 and 1918.

Year.	Number of producers.	Ore	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	61	349,655	$1,986,001	157,218	762,627	448,431	15,402	$2,363,882
1918	55	293,754	1,361,321	322,690	551,987	158,583	....	1,831,611
Increase or decrease, 1918	....	−55,901	−624,680	+165,472	−210,640	−289,848	−15,402	−532,271

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[1] Nevada Bunker Hill Mining Co. Statement to stockholders, May 1, 1919.

Altogether 293,754 tons of ore was mined in Esmeralda County in 1918 by 55 producers, 55,901 tons less than was mined in 1917 by 61 producers. Of the total ore 88,092 tons of ore and 164,121 tons of old tailings treated by cyanidation and 100 tons by amalgamation yielded $854,050 in gold and 219,364 ounces of silver, or an average value per ton of $4.25. There was 33,507 tons of ore treated at milling plants, which produced 5,766 tons of concentrates, containing gold, silver, copper, and some lead. These concentrates, with 7,934 tons of crude ore, were shipped to the smelters. The crude ore contained $268,262 in gold, 72,208 ounces of silver, 101,849 pounds of copper, and 106,783 pounds of lead, valued in all at $373,209, or an average value per ton of $47.04. There was no placer production reported in 1918.

Cuprite district.—A small quantity of lead ore containing silver was shipped from the Ella claim.

Desert district.—The Carrie property yielded a small quantity of oxidized silver-lead ore, shipped to the smelter by lessees.

Goldfield district.—All metals produced in 1918, with the exception of silver, decreased in quantity, and the total value was $724,623 less than in 1917, as is shown in the following table:

Mine production of the Goldfield district, Nev., 1904–1918.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	339,488	$1,900,082	78,184	728,255	....	$2,163,320
1918	264,237	1,212,572	90,560	548,847	....	1,438,697
Increase or decrease, 1918	−75,251	−687,510	+12,376	−179,408	....	−724,623
Total, 1904–1918	....	81,464,749	1,297,273	7,413,705	26,080	83,685,409

Twenty-two producers in the Goldfield district reported in 1918 the production of ore with an average value per ton of $5.44, against an average value of $6.37 in 1917. The larger part of the output, or 61,363 tons, was treated at milling plants by the cyanidation process and yielded 35,114.86 ounces of gold and 37,370 ounces of silver. There was also 33,350 tons of ore concentrated, yielding 5,666 tons of concentrate, which contained 11,103.87 ounces of gold, 29,833 ounces of silver, and 431,692 pounds of copper. In addition to the ore, 164,121 tons of old tailings were re-treated. The ore of shipping grade amounted to 5,403 tons and contained 12,439.43 ounces of gold, 23,357 ounces of silver, and 99,142 pounds of copper. The principal producers of these ores were the Goldfield Consolidated, Florence, Jumbo Extension, and Great Bend mines.

From the report of the Goldfield Consolidated Mines Co.[1] the following discouraging statement is taken:

> It must now be frankly admitted that the time has arrived when your company can no longer operate its Goldfield property at a profit by the methods used in the past, and it will now be the attempt of the management to evolve some scheme whereby the remaining scattered and small bodies of ore can be stoped and shipped sporadically to the smelters without the company taking the risk of large loss by attempting to keep up its staff and heavy overhead expenses.

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[1] Goldfield Consolidated Mines Co. Twelfth Ann. Rept., for year ending Dec. 31, 1918.

There was treated in the Goldfield mill 94,654 tons of ore having a gross value of $1,065,381. Of this amount, $921,514 was recovered. In addition, 164,121 tons of tailings were treated, from which $116,804 was recovered. An amount of $24,811 was received from interest, royalties, etc. Operating costs, including sums paid to lessees, totaled $1,059,696, showing a net profit of only $3,433. A total of 4,848 feet of development work was performed at a cost of $6.72 a foot.

Production of Goldfield Consolidated Mines Co., 1918.

	Production (short tons.)	Total value.	Average per ton.
Tons of ore milled	94,654	$1,065,381.45	$11.25
Loss in tailing and smelter discount		143,866.48	1.52
Value recovered		921,514.97	9.73
Tons of tailing re-treated	164,121	208,656.35	1.27
Loss in tailing		91,851.88	.56
Value recovered		116,804.47	.71
Total value recovered from ore and tailing		1,038,319.44	
Cost of ore purchased and amount paid lessees		182,625.61	
Value realized		855,693.83	
Net costs		852,260.02	
Net realization from operations		3,433.81	

The following table indicates the trend of operations for the past three years, exclusive of cost and recovery from tailing re-treatment.

	1916	1917	1918
Crude ore treated . . . tons	338,680	250,550	94,654
Heading value	$7.52	$8.14	$11.25
Tailing loss and smelter discount	.99	1.10	1.52
Value recovered	6.53	7.04	9.73
Percentage	86	86	86
Operating cost, including expense account lessees, but excluding direct expense of tailing treatment	$5.41	$6.67	$10.14
Operating profit	1.12	.37	[a].41
Miscellaneous earning	.22	.17	.29
Net profit	1.34	.54	[a].12
Development work performed . . . feet	28,333	16,477	4,848
Ratio development work performed to tons of ore treated	11:1	15:1	19:1

[a] Loss.

This comparison shows the tonnage treated has precipitately decreased, and that operating on this smaller tonnage, together with less efficient labor and higher costs for supplies, has caused constantly increasing costs per ton. The grade of the ore has increased somewhat on account of mining in more restricted areas, but the increase has not been in proportion to the increase in costs, so the profit has been reduced to nothing.

It will be noted the amount of development work (4,848 feet for the year) has decreased in even greater proportion than the tonnage. This is due to both the lack of efficient labor and the negative results obtained from recent exploration work. It is now confined almost wholly to the upper levels and consists of short crosscuts into vein walls or advance through old stoped areas in search of pay values in the filling.

There is no measurable ore reserve. Present exposures may reasonably be expected to produce 3,000 tons per month for six months, and thereafter at a slower rate until a total of 30,000 tons is produced, having an average grade of $10 to $12 per ton. Under present conditions any further operating profit is problematic.

Should development work continue either on company account or by lessees, other bodies of ore will be found, but, owing to extensive past development work, such new bodies are apt to be small and profitable only over short periods.

The leasing policy under a split-check system was gradually extended during the year until now, with the exception of a few stopes, the entire mine is open to lessees. About 40 sets are operating, and their production for the year was 25,085 tons, at a cost to the company of $6.80 per ton in payment of labor and powder used, also for whatever development work the lessees have performed. The present lease production (1,500 tons monthly) is becoming so small it is no longer profitable to maintain all the necessary mining and milling facilities for their convenience. If the few remaining blocks were given over to lessees on the same system, the lessees would make some profit for a few months, but the tonnage treated would be increased so little the company would be apt to continue to lose money in keeping the property operating.

Effort to treat the mine dumps has not been profitable. This year 2,422 tons, averaging $2.98, were treated by flotation. The operation resulted in a slight loss. There is no indication the remainder of the dumps, estimated at 50,000 tons, would show any higher values. Careful sorting by lessees has produced a few cars of milling ore, but at no profit to the lessee.

Gold Mountain (Divide) district.—Some silver ore containing gold from the Divide property was shipped and treated in the mill at Goldfield in 1918. The district is 6 miles south of Tonopah, the nearest railroad station and supply point. The discovery of pay ore in the Divide mine, on the east flank of Gold Mountain, caused considerable activity in the camp during 1918. Many mining claims were located in all directions, and companies were incorporated to work them. A recent article[1] gives the development as follows:

> In the Tonopah Divide mine a cross vein has been found in exploring what has been known as the main silver vein on the 370-foot level. The newly opened shoot is said to be the older fissure and the source of enrichment of the ore channel that has been opened for a length of over 300 feet. The shaft was sunk for the purpose of cutting, on its dip to the north, a vein that crops near the high summit to the south and that had produced rich ore from surface workings. A crosscut south on the 165-foot level penetrated the silver vein 140 feet from the shaft. This vein outcrops boldly in places, but shows little of value at the surface. The shaft was continued to the 370-foot level, and crosscuts were driven to the silver vein on the 265 and 370 foot levels. A crosscut extended south on the 265-foot level cut the gold vein 580 feet from the shaft, and a drift east on this vein exposed gold ore assaying from $40 to $80 per ton, varying from 2 to 4 feet wide. Drifts on the silver vein were extended both ways from the crosscuts on three levels, and at 50-foot intervals raises and crosscuts have been driven to block out the ore for a distance of over 300 feet along the vein, showing a mean width of 25 feet of ore. On the 370-foot level the southeast footwall drift, at a point 250 feet from the shaft crosscut, exposed the footwall of the new vein. This wall, like that of the silver vein, stands nearly vertical, with a slight southeast dip. The silver vein has a southeast strike, the new vein northeast, and the gold vein almost due east. High-grade ore was found at the footwall of the new vein, the faces for several days here assaying from $150 to $300 per ton. A drift was started southwest along the footwall of the new vein and a crosscut through the latter, back of the footwall of the silver vein. The rock between these faces was broken down to the point where a 12-foot face was exposed. Of this ore, a width of 5 feet assayed $236 and 7 feet sampled $87; car samples averaged $177 per ton. The crosscut was continued 31 feet before the hanging wall appeared. At 22 feet the face assay dropped to $48, but after the next round of shots it was $68 per ton. A crosscut here back into the silver vein gave an average of $265 for a length of 9 feet. The area about the point of junction of the two walls is greatly crushed and contains seams and masses of kaolin, filled with particles and sheets of glassy horn silver. Large pieces of this ore have been found containing 1,000 ounces of silver per ton. At other points native silver is present. The main shaft is being sunk below the 370-foot level by means of auxiliary hoisting equipment and is down 465 feet. Sinking will continue to water level, estimated to be not less than 700 feet, and stations will be cut at 100-foot intervals. * * * The district geology shows the mountain to be composed of a series of rhyolites, the upper strata being a hard fine-grained and glassy rhyolite showing distinct phenocrystals of quartz. Below this is a thin bed of fine-grained rhyolite breccia and below this is a series of fine-grained rhyolites, the distinguishing features of which are the stratifications due to the floor structure of this series. The lowest rock exposed on the mountain is a rather coarse-grained rhyolite breccia. The silver vein was found in the ryholite breccia, but the

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[1] Important developments in the Divide district: Min. and Sci. Press, vol. 118, p. 127, Jan. 25, 1919.

gold vein was found on the 265-foot level incased in the upper rhyolite, owing to fault action that has brought this rhyolite down to the level of the breccia, and the opinion is expressed that only at and below the 465-foot level will this vein be found incased in the breccia that forms the casing of the other ore channels. Ore from the Tonopah Divide mine is now being hauled to the McNamara mill at Tonopah, and an an early increase in production is probable. Shipments have been at the rate of 300 tons weekly, and until recently most of this ore went to the Goldfield Consolidated mill.

Exploration at adjacent properties has been in progress for several months. On the Brougher Divide, adjoining the Tonopah Divide mine on the northwest, drifts have been advanced for a considerable distance in the Divide vein on the 177-foot level, but no pay ore has been found. The shaft is being sunk deeper; it is now below the 375-foot point; and lateral work is to be resumed at the 400-foot level.

The Gold Zone, adjoining the Tonopah Divide on the southeast, explored the main silver vein on its 295-foot level and had a full face of $11 ore near the Divide boundary. Sinking was resumed and the vein has just been cut on the 500-foot level, not far from the Divide end line.

The Tonopah Dividend, adjoining the Brougher on the northwest, has been exploring on the 300-foot level and has crosscut the main silver vein, known in this territory as the Brougher vein, securing some good assays. Drifts are now being started both ways in this vein, which is over 40 feet wide in this territory.

The Divide Extension has a shaft down over 150 feet, but has not been working for some time. * * * Sinking will be resumed at once.

The East Divide, east of the Gold Zone, is sinking with good equipment near a prominent blow-out, where the vein cropping yield assays up to $5 in gold. The shaft, down 175 feet, is in the breccia typical of the Tonopah Divide mine, and crosscuts will be driven at the 200-foot level.

The Hasbrouck is driving a long tunnel, and has cut good ore in it and in the shaft workings. It has produced shipping ore in considerable quantity.

The Sutherland Divide, situated over 2,000 feet north of the Divide, has a 400-foot incline shaft, and has produced shipping ore from this shaft and from surface workings. It is to be equipped for lateral work on the 300 and 400 foot levels, and a crosscut is now being driven at 300 feet.

The Gold Reef group, southeast of the central properties, and the Gold Seam, south of the Gold Reef, show good vein croppings and are to be developed at depth.

Hornsilver district.—Most of the ore mined in the district was treated by the Silver Mines Corporation in its cyanidation plant. There was also some ore from the Panhandle and Orleans properties treated by cyanidation at Goldfield and Tonopah. The total output of the district in 1918 aggregated 21,945 tons of ore, valued at $234,932.

Klondyke district.—Silver ore was shipped from the original Klondyke property to various smelters during 1918. Some ore was also shipped from the Marinette claims.

Lida district.—Three producers reported the output of 215 tons of ore, containing $472 in gold, 8,537 ounces of silver, 141 pounds of copper, and 55,914 pounds of lead, valued in all at $13,014, or an average value per ton of $60.53. Some ore producing lead concentrate containing silver was milled from the Treasure State property. There was also a small quantity of lead ore and some silver ore from the Eagle Pass and Tip Top claims.

Lone Mountain district.—Seven producers reported the output in 1918 of 239 tons of ore, containing $77 in gold, 8,350 ounces of silver, 1,890 pounds of copper, and 64,596 pounds of lead, valued in all at $13,480, or an average value per ton of $56.40. The Nevada Alpine property was the principal producer of oxidized lead ore, containing considerable silver.

Montezuma district.—Four small shipments of silver ore, one of which contained some lead, were made from the district in 1918. The largest production came from the Bullion property.

Silverpeak district.—Lessees continued to recover some bullion from ore of the Pittsburg Silverpeak property, and also shipped some rich gold and silver product, probably the clean-up of the old milling plant. There was also some silver ore shipped from the Crescent property.

Tokop district.—The producers in the Tokop district were the Blue Jay, Fissure, Little George, and May Day properties, which produced principally ore of shipping grade containing gold and silver. A small quantity of ore was milled from the Fissure property at a custom plant near Horn Silver.

EUREKA COUNTY.

Mine production in Eureka County, Nev., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	45	7,165	$30,282	72,269	72,841	1,783,933	$263,136
1918	36	4,936	35,743	66,977	67,618	1,197,292	204,430
Increase or decrease, 1918		−2,229	+5,461	−5,292	−5,223	−586,641	−58,706

[a] Includes placer production.

Thirty-two operators in Eureka County in 1918 produced 4,936 tons of ore, 2,229 tons less than was produced by 40 operators in 1917. The total average value per ton increased from $36.34 in 1917 to $41.08 in 1918, and the gold and silver value in this ore from $12.15 to $20.47 a ton. There was treated in gold and silver mills 442 tons of ore, which yielded bullion containing $2,370 in gold and 26 ounces of silver, valued in all at $2,396, or an average total value per ton of $5.42. First-class ores amounting to 2,643 tons, shipped directly to smelters, contained $23,573 in gold, 61,899 ounces of silver, 15,759 pounds of copper, and 1,101,336 pounds of lead, valued in all at $167,559, or an average value per ton of $63.40. Placer bullion reported from four sources amounted to $1,660 in gold and 7 ounces of silver.

Cortez district.—The Mount Tenabo property was operated and yielded some silver ore containing gold. Three other producers reported shipments from mining claims in the district, two of which yielded oxidized lead ore.

Eureka district.—Twenty producers in the Eureka district reported the output of 3,804 tons of ore, containing $27,643 in gold, 51,980 ounces of silver, 63,517 pounds of copper, and 1,142,937 pounds of lead, valued in all at $176,461, or an average value per ton of $46.39. About half of the tonnage was old slag and speiss from the Richmond-Eureka smelter dumps, containing silver and gold and some copper and lead. There were important shipments of copper ore and lead ore from the Connelly property and oxidized lead ore from the Holly claims. The other producers were the Lucia Tuffa, Bullwhacker, Distinction, Helen Mortimer, Pack Saddle, and Silver Lick properties.

Lynn district.—The Gold Quartz mine of the Lynn Big Six Co. produced ore from which some gold and silver bullion was recovered in its amalgamation mill. There was also a small lot of siliceous gold ore shipped to the smelter. The Greenstone property produced a small quantity of oxidized copper ore of smelting grade. Sluicing operations carried on at the placers resulted in the production of $1,660 in gold and 7 ounces of silver. It is possible that this does not represent all of the production, as some of the gold is sold at a premium direct to manufacturers of jewelry. The principal part of the placer output came from the Bulldog placer, and some from the Compromise property.

Mineral Hill district.—Five producers reported 514 tons of ore, containing $148 in gold, 7,472 ounces of silver, 2,869 pounds of copper, and 48,941 pounds of lead, valued in all at $11,804, or an average value per ton of $22.96. The Mineral Hill property produced ore mined by lessees and also some sorted ore from the old mine dumps. From the Union mines a small output of ore, containing lead and a little silver, was shipped directly to the smelter.

HUMBOLDT COUNTY.

Mine production in Humboldt County, Nev., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	104	104,564	$246,645	859,837	567,610	511,221	$1,154,074
1918	96	119,343	251,825	869,662	249,271	255,186	1,201,175
Increase or decrease, 1918	....	+14,779	+5,180	+9,825	−318,339	−256,035	+47,101

[a] Includes placer production.

From mines in Humboldt County 92 producers mined 119,343 tons of ore in 1918, as compared with 104,564 tons of ore and 100 producers in 1917. The total average value per ton decreased from $11.03 in 1917 to $10.06 in 1918. Milling plants using amalgamation and cyanidation, but principally the latter process, treated 110,453 tons of ore and a quantity of old tailings, which yielded $215,428 in gold and 751,732 ounces of silver and had an average value per ton of $8.70. Some gold and silver concentrate was also produced at the milling plants and shipped to smelters. Ore of shipping grade aggregated 7,253 tons and contained $33,043 in gold, 100,079 ounces of silver, 248,700 pounds of copper, and 95,596 pounds of lead, valued in all at $201,338, or an average value per ton of $27.76. There were also some shipments of old tailings and slag containing copper and lead. The placer output reported from four sources amounted to $929 in gold and 16 ounces of silver, as against $1,206 in gold and 10 ounces of silver in 1917.

Amos district.—The Colorado No. 1 property was the only producer, yielding some milling ore which was treated in an arrastre and produced a small quantity of gold bullion.

Antelope district.—Considerable activity in mining was experienced in the district when the Mason Valley Mines Co. began operations on the Majuba Hills property, which produced and shipped copper ore to the smelter at Thompson. Eleven other producers, among them the Last Chance, Nevada Superior, and Dandy properties, shipped a small quantity of ore containing gold, silver, and lead. Reference was made by Knopf [1] in 1918 concerning the occurrence of tin in the district.

Echo district.—Some ore was shipped from the Rye Patch property by the American Mining & Exploration Co. in 1918. This company also operated in the Imlay district.

Gold Run district.—Low-grade copper ore, carrying silver, was shipped from the Adelaide property to a California smelter in 1918. There were also small shipments of ore from the Caroline and Oro Belle properties. The Gold Run placers were in the hands of lessees during 1918 and a small output of gold was shipped to the mint.

Imlay district.—The American Mining & Exploration Co., operating the Imlay mine, shipped considerable silver ore. This company also operated the Rye Patch mine in the Echo district.

Jackson Creek district.—The Champion mine, situated near Sulphur, produced a small quantity of sulphide copper ore containing silver.

Kennedy district.—The Independence Day prospect yielded a small quantity of ore rich in silver.

National district.—The National mine produced in 1918 a few tons of very rich gold-silver ore mined by lessees. There was also a few pounds of rich ore mined from the Buckskin property.

Rochester district.—Twenty producers reported 95,747 tons of ore, containing $177,120 in gold, 810,974 ounces of silver, 4,215 pounds of copper, and 42,530 pounds of lead, valued in all at $992,154, or an average value per ton of $10.36. The greater part of the ore, 91,859 tons, was milled and produced gold and silver bullion, recovered chiefly by cyanidation, and 3,524 tons of ore, containing 358.28 ounces of gold, 58,190 ounces of silver, 4,215 pounds of copper, and 42,530 pounds of lead, was shipped directly to smelters. The largest quantity of ore was treated in the milling plant of the Rochester Mines Co., followed by the Nevada Packard property, which is also equipped with a cyanidation plant. At the Lincoln Hill mill some ore from the mine was treated by cyanidation. Silver ore and some lead ore were shipped directly to the smelter from the Buck and Charley mine. There were also shipments made from the Octopus and Rochester Lincoln Consolidated properties. A small quantity of placer gold was reported by one operator.

Rosebud district.—The Dreamland and Abe Lincoln properties made small shipments of ore. Combined with the production from 7 other producers, the total output of the district was 173 tons of ore, containing principally silver and in two instances some copper. Altogether the total output was valued at $8,454, or an average value per ton of $48.87.

Seven Troughs district.—Seventeen producers reported the output of 18,944 tons of ore, containing $45,838 in gold and 4,038 ounces of silver, valued in all at $49,876, or an average value per ton of $2.63. All of this output, with the exception of 6 tons shipped to smelters, was treated in the milling plant of the Seven Troughs Coalition Co., equipped for amalgamation. There was also some product shipped from the dismantling of the Earl and Darby cyanidation plants.

Sierra district.—Three producers reported 70 tons of ore, containing principally silver, with a little gold. About half of the production was from the Silver Coin property. The Little Pearl placer yielded a small quantity of gold bullion.

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[1] Knopf, Adolph, U. S. Geol. Survey Mineral Resources, 1918, pt. 1, p. 26, 1919.

Trinity or Arabia district.—A small quantity of copper-lead ore was shipped from the Mohawk property and some old tailings and a little slag from early reduction plants operating on ores from different mines in the region.

Unionville district.—The Arizona mine[1] at Unionville was being equipped in September, 1918, with new machinery, and a new mill was under construction to use stamps, tube mills, and flotation apparatus. The mine has been drained to a depth of 400 feet by a tunnel, giving access to the vein below the deepest of the old drifts and stopes. This mine is being reopened by the Sunset Mining & Development Co. Records of the Arizona mine are said to show that after its discovery in 1862 it produced quantities of rich ore and 900 tons of selected ore, which was hauled by freight team to Sacramento and shipped in sailing vessels to Swansea, Wales. This netted the company $480,000.

Warm Springs district.—The Ashdown property, near the Nevada-Oregon line, was the producer of some gold bullion

Winnemucca district.—Various small shipments of ore were made from the district in 1918 and aggregated 248 tons, containing $2,221 in gold, 5,861 ounces of silver, 4,742 pounds of copper, and 854 pounds of lead, valued in all at $9,314, or an average value per ton of $37.56.

LANDER COUNTY.

Forty-eight producers reported the output of 25,432 tons of ore, 1,584 tons more than was reported by 47 producers in 1917. The total average value of the ore decreased from $35.12 in 1917 to $32.19 in 1918, and the gold and silver value increased from $5.61 to $9.59. At gold and silver mills, 5,028 tons of ore yielded $38,690 in gold and 2,714 ounces of silver, valued in all at $41,404, or an average value of $8.23 a ton. The ore of shipping grade amounted to 19,904 tons, containing $41,400 in gold, 161,065 ounces of silver, 2,261,246 pounds of copper, and 227,971 pounds of lead, valued in all at $777,179, or an average value per ton of $39.05. The placer output reported by 6 operators was $76,279 in gold and 490 ounces of silver, against a production in 1917 by 33 operators of $66,746 in gold and 460 ounces of silver.

Battle Mountain district.—Twenty-three producers reported the production of 15,845 tons of ore, containing $8,953 in gold, 43,480 ounces of silver, 1,999,040 pounds of copper, and 68,894 pounds of lead, valued in all at $551,087, or an average value per ton of $34.78. All the ore, with the exception of 61 tons treated in a milling plant, was shipped directly to the smelters. The largest producer of copper ore was the Copper Canyon property, followed by the Elder Creek, and the Blue Dick properties. The other important producers were the Contention, Copper Queen, Black Jack, White mine, and Silver Bow No. 3 claim. Six placer operators reported the production of $76,279 in gold and 490 ounces of silver, most of which was recovered by drift mining. The largest part of the output came from the Dahl placer. There were smaller productions from the Iron Canyon and Marietta & Piute placers.

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[1] Min. and Sci. Press, vol. 117, p. 428, Sept. 28, 1918.

Bullion district.—Silver ore containing gold was shipped from the Maysville property in 1918. There was also said to have been some rich gold ore shipped from the Gold Quartz property.

Cortez district.—The Utah, Garrison, and six other properties produced silver-lead ore shipped directly to the smelters.

Hilltop district.—From the Kimberly Consolidated mine oxidized copper ore, containing considerable silver and gold, was shipped directly to the smelter. The Pittsburg Red Top and Gold Star properties were small producers of silver-gold ore.

Lewis district.—The Eagle claim was operated by a lessee, and produced a small lot of silver ore.

New Pass district.—Gold bullion was recovered from ores and old tailings of the Nevada Austin mines in 1918. The property is equipped with a 75-ton cyanidation mill.

Reese River district.—Nine producers reported the output of 107 tons of ore, containing $1,136 in gold, 7,638 ounces of silver, 181 pounds of copper, and 3,227 pounds of lead, valued in all at $9,048, or an average value per ton of $84.56. All the ore was of shipping grade and was the result of small mining operations. The largest shipment was silver ore from the Austin Manhattan Consolidated property.

LINCOLN COUNTY.

Mine production in Lincoln County, Nev., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	23	154,087	$48,899	523,399	440,197	10,714,152	1,332,521	$1,657,688
1918	12	115,001	23,187	421,310	439,767	8,893,658	581,718	1,237,505
Decrease, 1918	....	39,086	25,712	102,089	430	1,820,494	750,803	420,183

Twelve operators in Lincoln County in 1918 reported 39,086 tons of ore less than was produced by 23 operators in 1917. The average value per ton remained at $10.76, and the gold and silver value increased from $3.12 to $3.86 per ton. The greater part of the ore, 101,173 tons, was of shipping grade and contained $15,629 in gold, 371,585 ounces of silver, 436,228 pounds of copper, 7,822,016 pounds of lead, and 331,921 pounds of zinc, valued in all at $1,080,530, or an average value per ton of $10.68. At concentrating plants, 3,828 tons of ore yielded 2,736 tons of concentrates, containing $7,557 in gold, 49,725 ounces of silver, 3,539 pounds of copper, 1,071,642 pounds of lead, and 249,797 pounds of zinc, valued in all at $156,973, or an average value per ton of $57.37. No placer production was reported in 1918.

Atlanta district.—The Nevada Park mine produced a small quantity of silver ore which was shipped directly to the smelter.

Groom district.—Work progressed as usual on the Groom property, which produced some sulphide lead ore rich in silver and containing a little copper. This ore was hauled to Indian Springs and shipped to the smelter.

Jack Rabbit district.—Three producers reported the output of 5,871 tons of ore, containing gold, silver, copper, lead, and zinc. The principal part of the output came from the Uvada Copper Co., operating the Gypsy & May Day group of claims, and the Black Metals Corporation, operating the Day mine.

Pioche district.—Seven operators produced 107,948 tons of ore in 1918, most of which was shipped to smelters near Salt Lake City. This ore contained $21,257 in gold, 353,309 ounces of silver, 18,220 pounds of copper, 7,334,381 pounds of lead, and 566,955 pounds of zinc, valued in all at $951,400, or an average value per ton of $8.80. Included in this output was 3,828 tons of ore which produced lead and zinc concentrate and 10,000 tons of old tailings, from which was recovered 1,018 tons of concentrate containing lead, silver, and gold. The principal part of the output of the district was from the Prince Consolidated property, followed by the shipments of lessees of the Amalgamated-Pioche mine. There were also shipments from the Virginia Louise mine, adjoining the Prince property. The Virginia Louise property, which is opened by a vertical shaft 480 feet deep, and has 2,500 feet of drifts and raises, had been idle for a long time. Operations were resumed in May and shipments were begun in August. Most of the ore is similar to that of the Prince mine, being valuable as flux, as it contains iron and manganese.

From the Prince Consolidated report[1] the following paragraphs are taken:

> The litigation with adjoining mining company has been settled. Agreement was entered into by both sides, defining the ore bodies by vertical lines, thereby preventing all possible future litigation. A profitable contract was obtained from the Virginia-Louise Co. to transport their ore from the mine to Pioche over the Prince tramroad. * * *
>
> We had a serious washout on our tramroad in September and shipments were suspended until four railroad bridges could be constructed; then followed the influenza, which likewise delayed shipments.
>
> The demand for our ore was greater in 1918 than any year previous, so in April it was decided to sink and equip the property with a new shaft and develop other ore bodies. * * *
>
> The shaft has two compartments, the working compartment is 4½ feet by 5 feet and contains self-dumping skip of 2½ tons capacity. The other is 5 feet by 5½ feet for manway, air and water pipes. The location of the new shaft was selected having in view the continued sinking of it to the lower or sulphide beds explored with diamond drills. * * *
>
> The ore channel seems to follow the strike of the Prince system of fissures (which were undoubtedly the source of the mineralization of the ore beds) to the southeast. The channel varies in width; the 20-foot bed has been found in places 600 feet wide, but a basis of 200 feet average is considered conservative.
>
> The bed of ore developed in the Davidson section is in this channel, but is a separate and distinct bed from those found in the Prince section. It overlies the Prince beds, but is eroded from the surface on Prince section. This is accounted for by a system of north-south and east-west faults, which have thrown the Davidson claim and the southern portion of the California claim lower geologically than the balance of the group, which has preserved the Davidson bed from erosion. * * *
>
> The position of the Davidson bed in the series is approximately 150 feet above the Prince "big bed," with lime and shale between. The Prince "big bed" and the underlying ones should be found below the fifth level in the Davidson section and available for mining from the sixth level.
>
> The ore in the Davidson bed was proved so extensive and of such uniformly higher grade that development was confined to it.
>
> About half of the output for the last three months of the year was mined from the Davidson section, the other half from the Prince section. Large tonnages are already developed for future extraction and development is being carried on so future operations can be conducted for a long period of time. * * *
>
> The mill at Bullionville constructed for the treatment of Bullionville and Dry Valley Tailings, was not operated successfully.

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[1] Prince Consolidated Mining & Smelting Co. Ann. Rept. for year ending Dec. 31, 1918.

LYON COUNTY.

Mine production in Lyon County, Nev., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	65	329,910	[a] $50,455	[a] 5,762	19,397,002	2,250	$5,350,779
1918	44	414,287	71,860	52,442	17,138,747	....	4,357,573
Increase or decrease, 1918	....	+ 84,377	+ 21,405	+ 46,680	− 2,258,255	− 2,250	− 993,206

[a] Includes placer production.

Forty-four producers in Lyon County reported 414,287 tons of ore in 1918. This was 84,377 tons more than was reported by 64 producers in 1917. The total average value per ton decreased from $16.22 in 1917 to $10.52 in 1918, and the gold and silver value of the ore increased from 17 cents to 30 cents a ton. There were 11,821 tons of ore and 2,730 tons of old tailings treated at amalgamation and cyanidation plants, which yielded $67,605 in gold and 36,532 ounces of silver, valued in all at $104,137, or an average value per ton of $7.16. At one leaching mill in the county some copper ore was treated by the acid process. Ores of shipping grade, 339,884 tons in quantity, were shipped to smelters and produced $4,256 in gold, 15,910 ounces of silver, and 15,165,506 pounds of copper, valued in all at $3,766,046, or an average value per ton of $11.09.

Ramsey district.—A small quantity of bullion was shipped from some ore treated by amalgamation from the Ramsey-Comstock property.

Silver City district.—Nineteen producers reported the output of 14,507 tons of ore, containing $66,924 in gold and 36,562 ounces of silver, valued in all at $103,486, or an average value per ton of $7.13. Nearly all the ore, and some tailing, were treated in small plants using the cyanidation process. Most of the output was from the Como mine, the production of which is included in this district. There is a 50-ton cyanidation plant at this property, which is opened by a vertical shaft 300 feet deep. The Rapidan mine, about 2,000 feet distant, operated by the same company, has an incline shaft 350 feet deep. The mines were operated continuously, and mill operations began in April.

Talapoosa district.—Some silver ore, containing gold, was mined from the Talapoosa property and shipped to a smelter in California.

Yerington district.—Twenty-three producers reported the output of 398,638 tons of ore, containing $60 in gold, 980 ounces of silver, and 17,138,747 pounds of copper, valued in all at $4,234,311, or an average value per ton of $10.62. Nearly all of this ore, with the exception of 59,749 tons which was milled, was treated at the smelter at Thompson, and the remainder was shipped to California for smelting, or sold to ore purchasers at Reno. A large part of the district production was from the Bluestone property, which is equipped with a 500-ton concentration mill using oil flotation. All of the oxidized ore went directly to the smelter, and the sulphide ore was treated in the mill. Copper ore was produced also by the

Nevada-Douglas, Montana Yerington, Empire Nevada, and McConnell properties.

The Mason Valley smelter[1] at Thompson treated 117,251 tons of copper ore from the mine, in 1918, according to the annual printed report, from which the following paragraphs are taken:

> Operations were continuous throughout the year. Two furnaces were in blast from December 28, 1917, to April 27, 1918, when it became necessary to shut one down on account of the power shortage due to the necessity of overhauling the long-distance transmission lines. After this condition was remedied it was found advisable to operate only one furnace. * * *
>
> During the year 336,943 tons of ore and 11,689 tons of the metal-bearing fluxes were smelted, of which 117,251 tons of ore were from the company's property, 788 tons from properties held under option, and 218,904 tons from outside sources. * * *
>
> There was produced 808.969 ounces of gold, 91,824.13 ounces of silver, and 15,475,851 pounds of copper. * * *
>
> Of the ores from outside sources smelted during the year about 88 per cent was produced by the Bluestone Mining & Smelting Co. and the Nevada-Douglas Consolidated Copper Co. The copper produced from these companies' ores is returned to them for sale.
>
> In view of the uncertainly of the price and market for copper, your directors decided that the interests of the stockholders would be better served by ceasing operations temporarily. The mine and smelter were, therefore, closed down on February 28, 1919. Some development work is still in progress at the mine.

The Nevada-Douglas property[2] produced copper at the rate of about 300,000 pounds a month during 1918. The statement continues:

> On June 1, 1918, owing to the fact that the mines of the company, with the exception of the Western Nevada, were running very low on shipping ore, we inaugurated an active development campaign in the Ludwig, Casting Copper, and Western Nevada mines. This campaign we have kept up continuously, with the result that we have added sufficient ore of a 3½ to 4 per cent average grade to carry a 250-ton production for eighteen months or more if no further ore were uncovered. Some of the largest ore bodies which the mines have ever had are now uncovered in the 800 level of the Ludwig, and the 400 and 500 levels of the Western Nevada. While the development work in the Casting Copper is promising, and we have new ore to-day on the 100, 200, and 350 foot levels, these ore bodies are not demonstrated to a point which justifies the assertion as yet that there is any considerable tonnage in sight.

MINERAL COUNTY.

Mine production in Mineral County, Nev., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	133	274,571	$713,003	407.302	3,461,969	357,876	$2,024,514
1918	85	157,135	578,925	351,760	2,228,337	171,660	1,493,272
Decrease, 1918	....	117,436	134,078	55,542	1,233,632	186,216	531,242

[a] Includes placer production.

Eighty-one producers in 1918 reported 157,135 tons of ore, or 117,436 tons less than was reported by 129 producers in 1917. The total average value per ton increased from $7.37 in 1917 to $9.50 in 1918, and the value of the gold and silver from $3.82 to $5.92. At gold and silver mills 121,278 tons of ore was treated, most of it by cyanidation, yielding $552,449 in gold and 138,919 ounces of silver, or an average of $5.14 a ton. This bullion included the recoveries made from 13,265 tons of old tailings retreated by cyanidation. There was 22,592 tons of crude ore shipped to smelters, which contained $25,493 in gold, 212,793 ounces of silver, 2,228,337 pounds of copper, and 171,660 pounds of lead, valued in all at $800,873, or an average value per ton of $35.45. The output reported from 4 placers amounted to $983 in gold and 48 ounces of silver, against $428 in gold and 14 ounces of silver in 1917.

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[1] Mason Valley Mines Co. Ninth Ann. Rept., for year ending Dec. 31, 1918.

[2] Nevada-Douglas Cons. Copper Co. Statement Jan. 16, 1919.

Aurora district.—Gold and silver were recovered from ores of the Aurora Consolidated property and from tailings treated in the Baldwin cyanide plant. Operations at the Aurora Consolidated mines[1] were discontinued in October, 1918, after further development work had failed to expose payable ore in either Juniata or Silver Lining claims. The company's report says:

> The equipment of the Aurora Consolidated Mines Co. will be disposed of as rapidly as possible, the assets of the company turned into cash, and the proceeds applied on its debt to your company. Despite the opinions of the best engineers that could be obtained when the property was first acquired, and the encouragements that have been given since, the results of this investment have been most disappointing and a serious loss has resulted where it seemed that there was every prospect for a brilliant future and large profits. * * *
>
> During the year 104,086 tons of ore were treated, yielding $295,029. The total loss for the year was $83,657, exclusive of interest and indebtedness, which amounted to $19,566.
>
> For five years to date the property produced 633,332 tons, yielding $1,842,482 at a cost of $1,856,624.
>
> Operating costs (averaging $2.94 per ton for the same period) were lower than could be expected in the near future and the general tendency toward impoverishment of the veins with depth made any further operations or development work inadvisable.

Bell district.—The greater part of the Cedar Mountain Range is covered by the Bell district, over which intensive prospecting has been carried on since the beginning of operations two years ago at the Olympic mine and mill. The mine is near the north end of the Cedar Range, at Stewart Springs, about 25 miles northeast of Mina, on the Southern Pacific Railroad, the principal supply point for the district. The cyanide mill of the Olympic Co. was put into operation in 1916, treating 75 tons of ore a day. It is equipped with crusher, ball mills for fine grinding with accessory tube mills, cyanide vats, and Oliver filter. About 70 men were employed in 1918.

Recently new life was awakened in the district by the opening at depth of a deposit of lead-silver ore of milling and shipping grade in the Simon silver-lead mine, 23 miles northeast of Mina. This is an old property, said to have been located in 1876 by John Storey, who operated it intermittently for a number of years. As the property was far from a railroad and as the ore contained considerable zinc, it was found difficult to dispose of the mine. At a depth of 400 feet it is reported[2] the ore has been opened for a width of 140 feet between walls of lime and porphyry. At the 230-foot level sulphide lead ore was encountered. It is found that the zinc grows less and less with depth, much of the ore showing steel galena. In 1917 the output of this property was included in the total reported for the Columbus district. Several old properties are showing life, among them the Norman silver property and the adjoining Fagan mine, which is one of the oldest discoveries in the region.

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[1] Goldfield Consolidated Mines Co. Twelfth Ann. Rep., for year ending Dec. 31, 1918.

[2] Miner, F. L., The Simon lead and near-by properties: Salt Lake Min. Rev., vol. 21, p. 25, Aug. 15, 1919.

Buena Vista district.—A small quantity of ore was shipped to the smelter from the Silver Nugget and R. & S. group of claims in 1918.

Columbus district.—More than the usual mining activity has been in evidence for the last two years in opening the old properties of the district. About 400 feet of tunneling and drifting was done in 1918 by the Candelaria Mines Co. on the Lucky Hill mine, from which some ore was shipped to the smelter. The property has an old shaft 300 feet deep, and in the Mount Diablo and Argentum mines, also controlled by this company, there are several miles of drifts. All of these properties are near the line of Mineral and Esmeralda counties, having been originally recorded at Candelaria, in Esmeralda County. The camp is situated south of Mina at the terminus of a short branch line leaving the Southern Pacific narrow-gage road at Filben or Candelaria Junction.

Since 1913 about 125,000 tons of old tailing at Belleville has been worked, which yielded gold and silver by cyanidation. Some of the old tailings were shipped directly to the smelter in 1917, and after being in operation part of the season in 1918 the 130-ton tailing mill was closed.

As these old silver mines have again come to life, it is interesting to review some of the history of the district, which is reported[1] to have been discovered and organized by a company of Spaniards in 1863. The Northern Belle, the oldest and most productive mine was originally located in 1864. In 1873 a company was incorporated and a 20-stamp mill was built at Belleville, 8 miles from the mine. The second mill was built in 1876. Prior to June, 1878, the bullion yield of this mine had been $3,754,048.55, out of which $1,500,000 in dividends were paid. By the end of 1883, according to the report of the Mint,[2] the total amount of silver bullion aggregated $10,000,000, out of which fully $5,000,000 had been paid in dividends. These mills treated considerable custom ore, chiefly from the Mount Diablo property and also some from adjoining mines. In 1884 the bullion product[3] of the district was less on account of litigation. As a result, the Holmes Co., owning the adjoining property, became the purchaser of the Northern Belle mine and hoisting works at Candelaria and the mills at Belleville. The new company in 1884 received $116,372.66 from the sale of silver bullion.

After these changes in ownership, the output of the district diminished considerably and in 1887 the Mount Diablo[4] was the only property of consequence producing. In that year 5,988 tons of ore were milled and yielded $234,008.26 in silver bullion, and for four years after until 1891, the production averaged about the same from the Mount Diablo mine. In the same year the Holmes Co. again became active and produced $242,022 in silver bullion, but after that and until 1903, when Goldfield commenced to show activity, all mining camps in Esmeralda County recorded a very small output.

Hawthorne district.—The Lucky Boy and Emerald properties were the principal producers, shipping ore containing considerable silver.

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[1] Pratt, A. C., Carson City, Nev.: Internal commerce of the United States, 1890, Bureau of Statistics, Treasury Dept., 1891.

[2] Director of the Mint Rept. for 1883, p. 508, 1884.

[3] Idem for 1884, p. 348, 1885.

[4] Idem for 1887, p. 214, 1888. Reference is also made to the reports for each year concluding with the report for 1891.

Pinegrove district.—From the Pittsburg-Dolores or Rockland mine some gold and silver bullion was recovered from ores treated in the 75-ton cyanidation plant. This property is reported to have been closed down on May 1, on account of the high costs of material and labor.

Rand district.—Very little work was performed in the Rand district in 1918, and only a few small shipments were made from the Jumbo Copper and Nevada Rand mines. The ore contained principally gold and silver, with the exception of that from the Jumbo property, which yielded copper in addition to the precious metals.

Rawhide district.—The principal producer in former years, the Nevada New Mines Co., gave its property over to lessees and a number of them, including those working on other properties, shipped or treated 285 tons of ore, containing $12,820 in gold, 9,041 ounces of silver, and 7,842 pounds of copper, valued in all at $23,798, or an average value per ton of $83.50 Dry-washing of surface material from the quartz veins resulted in the production of $983 in gold and 48 ounces of silver, reported by 4 operators.

Santa Fe district.—Twenty-five producers reported the production of 12,897 tons of ore, containing $953 in gold, 42,012 ounces of silver, 1,923,259 pounds of copper, and 18,011 pounds of lead, valued in all at $519,289, or an average value per ton of $40.58. All the ore, with the exception of 25 tons treated at gold and silver mills, was shipped directly to the smelters. The largest shipments were from the Wall Street property. Other producers of importance were the Pilot, Havana, Tip Top, Calavada, New York, and Vacation properties, which shipped principally copper ore.

Silver Star district.—Eighteen producers reported 2,262 tons of ore, all of which, with the exception of 5 tons which was milled, was of shipping grade. The total output contained $830 in gold, 4,415 ounces of silver, 225,417 pounds of copper, and 9,812 pounds of lead, valued in all at $61,620, or an average value per ton of $27.24. The Dunlap group, owned by the Tonopah Mining Co., was the principal producer of copper ore. Next in importance were the Olga, Copper King, and Blue Jay claims.

NYE COUNTY.

Mine production in Nye County, Nev., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	114	514,361	$2,007,234	7,172,642	15,529	430,025	6,042	$7,959,328
1918	109	552,081	1,991,845	6,104,711	8,540	464,912	....	8,131,674
Increase or decrease, 1918	....	+37,720	−15,389	−1,067,931	−6,989	+34,887	−6,042	+172,346

[a] Includes placer production.

The output of 552,081 tons of ore in Nye County was reported in 1918 by 79 operators of deep mines. This was 37,720 tons more than was reported by the same number of operators in 1917. The total average value per ton decreased from $15.04 in 1917 to $14.47 in 1918. The value of the ore in both years was practically that of the gold and silver. At gold and silver mills 531,799 tons of ore and 15,137 tons of old tailings were treated, and produced bullion containing $1,811,009 in gold, and 5,800,520 ounces of silver, having an average value per ton of $13.92, and 303 tons of concentrates, which were shipped to smelters, and contained 658.49 ounces of gold and 107,938 ounces of silver. These and 483 tons of concentrates produced at concentration mills contained altogether $16,118 in gold, 149,057 ounces of silver, and 116,000 pounds of lead, having a total value of $173,411, or an average value per ton of $220.62. The ore of shipping grade amounted to 2,645 tons and contained $26,628 in gold, 151,795 ounces of silver, 8,540 pounds of copper, and 348,912 pounds of lead, valued in all at $205,305, or an average value per ton of $77.62. The placer gold reported from 30 operators amounted to $138,090 in gold and 3,339 ounces of silver, against a production in 1917 of $219,131 in gold and 5,754 ounces of silver.

Bellehellen district.—The Bellehellen property, operated by the Tonopah Kawich Co., produced silver ore containing considerable gold, which was recovered in the form of bullion in a custom plant at Tonopah. Some of the higher-grade ore was shipped directly to the smelter. There was also a small production of gold ore of shipping grade containing silver from the Clifford property.

Bruner section.—A small output of gold ore was mined and shipped from the Fly claim during development work on the property.

Bullfrog district.—Some bullion was recovered from ore from the Maryland property, treated in its amalgamation plant, and a small tonnage was shipped directly to the smelter. There was also some work performed by a lessee on the Montgomery Shoshone property, resulting in the clean-up of a small quantity of material of smelting grade.

Cloverdale district.—The principal producer, the Orizaba mine, produced silver ore which was shipped directly to the smelter. From three other properties shipments were made by lessees.

Ellendale district.—From the Ellendale property some ore was treated in an amalgamation mill, and produced gold and silver bullion.

Johnnie district.—From 277 tons of ore mined by four producers, and treated in the district in 1918, gold bullion was extracted by amalgamation.

Mammoth district.—During 1918 some lead ore, containing considerable gold and silver, was shipped directly to the smelter from one property. The post office of this district is at Bruner.

Manhattan district.—Twelve producers reported 33,595 tons of ore, containing $276,597 in gold and 1,187 ounces of silver, valued in all at $277,784, or an average value per ton of $8.27. The larger part of the output, all of which was milling ore, was from the White Caps property. Other producers of importance were the Manhattan Amalgamated, Crescent, April Fool, and Dexter properties. The White Caps mine is opened by a shaft 665 feet deep, and the reduction plant consists of a roaster and cyanide mill having a capacity of 125 tons per day. The ore, which is intimately associated with siliceous gangue, contains gold and silver with the sulphides of arsenic and antimony. Twenty-six placer operators reported the output of $64,281 in gold and 1,201 ounces of silver, valued in all at $65,482. The greater part of the gold was recovered by drift mining. The principal producer was the Black Cat, followed by the Top Knob, Bull Dog, September, China, Mustang Extension, and Thursday Fraction properties.

Philadelphia or Belmont district.—Some silver bullion, containing gold, probably recovered from recent milling operations, was reported by one operator.

Reveille district.—Seven producers reported 239 tons of ore, containing $65 in gold, 5,706 ounces of silver, 2,480 pounds of copper, and 125,374 pounds of lead, valued in all at $15,286, or an average value per ton of $63.96. Oxidized lead ore, containing silver, was shipped from the Southwestern Nevada property. There were smaller productions from six other producers.

Round Mountain district.—Eight producers reported an output of 12,737 tons of ore, all of which, with the exception of three tons shipped directly to a smelter, was of milling grade and was treated principally by amalgamation. Most of the ore was produced from the property of the Fairview Round Mountain Mining Co. and the property of the Round Mountain Mining Co. Placer gold was reported by three operators who produced $73,710 in gold and 2,137 ounces of silver, valued in all at $75,847. Most of this gold was from the property of the Round Mountain Mining Co.

The Round Mountain Mining Co.'s[1] property, operated partly by lessees in 1918, yielded gold and silver bullion from milling and placer operations. The company report gives details as follows:

> During the year ending December 31, 1918, 71,367 cubic yards of placer gravel were moved by hydraulicking, yielding 5,299.84 ounces of bullion having a value of $68,324.07. In addition to this amount $2,683.39 was received in royalties from the placer leases. The total operating cost was $48,792.38 and the total realization $22,215.08. This operating cost does not include the depreciation of pipe lines, main tail race, and placer equipment, but does include the cost of maintenance of pipe lines, sampling placer banks, and the development of branch races preparatory for 1919 operations. The gross value recovered exclusive of placer lease royalties was $0.9573 per yard. The operating cost was $0.6835 per yard, or a realization of $0.2738 per yard.
>
> Of the total yardage hydraulicked, 50,500 yards were moved from Sunnyside "A" pit; 8,930 yards from between the Llewellyn workings and the main tail race; 9,237 yards from the south bank of Great Western "A" pit; and 2,700 yards from the north bank of the same pit. The production from the Sunnyside "A" pit was $34,694.97, or $0.687 per yard, from the area between the Llewellyn workings and the main tail race $19,260.66, or $2.1569 per yard, from the Great Western "A" pit, south bank, $12,867.63, or $1.393 per yard, and from the north bank $1,500.81, or $0.5555 per yard. * * *
>
> During the year the production of the leases on bedrock in the Great Western "A" pit was $4,586.66 from an area of 91,100 square feet. The gross yield was $0.0503 per square foot, of which amount $0.011 per square foot was paid to the company in the form of royalties. The cleaning of this area cost the lessees $0.051 per square foot.
>
> Drift leases on small areas west of the Gold Leaf cut were let during the year to determine definitely the values in the gravel overlying bedrock and to guide the company in future operations in this area. 1,450 tons removed by these bedrock lessees from an average width of 6 feet of gravel yielded $6,923.71 or $4.775 per ton, including a value per yard for this six feet of bedrock material of $6.366. This area was found to be free from boulders and cemented gravel and the drift lease operations have proven a large additional yardage of a value not contemplated by the company, and no drift leases have been let since the above yardage values were determined.
>
> In 1918 the company cleaned 45,500 square feet of bedrock yielding $9,167.61, or $0.2015 per square foot. The average cost of cleaning this bedrock was $0.1286 per square foot. Segregated placer operating costs are shown in a table attached hereto. It will be noted that of the total cost, development or the cutting and installation of branch races represents 5.9 per cent, hydraulicking 72.8 per cent, bedrock cleaning 12.2 per cent, maintenance 4.6 per cent, and sampling of placer banks 4.5 per cent.

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[1] Round Mountain Mining Co. Thirteenth Ann. Rept., for year ending Dec. 31, 1918.

Labor represents 77.2 per cent of the total cost, administration and departmental costs were 10 per cent, power 2 per cent, and supplies 10.8 per cent. * * *

The final clean-up of the main tail race was made in November, 1918, and yielded $10,045.11. Of this amount $6,160 was obtained from the flume clean-up and $3,855.11 recovered from milling 180 tons of concentrates from the lower end of the main tail race, the concentrates showing a tonnage value of $21.58. This final clean-up represents 14.7 per cent of the total gold recovered. * * *

The production of the lode lessees of the Round Mountain Mining Co. for the year 1918 was 2,131 tons of ore, having a value of $78,202.34, or $36.69 per ton. In addition, 20 tons of ore having a value of $627.05, or $31.35 per ton, were produced from the Blue Jacket group, held under lease by the company. * * * All of this ore was milled by the company, the Huntington mills and one tube mill being used, and the expense of milling, marketing the bullion, maintaining the mill, together with a charge of $1 per ton for the use of the mill, was deducted from the value of the bullion before the royalty was computed.

The Fairview Round Mountain Mines Co.[1] owns the Fairview patented lode claim containing 19.546 acres and the lode rights of the Daisy group, consisting of the Blue Jay No. 3, Blue Jay No. 5, Daisy Fraction, and Solid Gold claims, comprising 40.9 acres. The output and costs are discussed in the company report as follows:

Mining operations in 1918 were conducted principally in the Fairview claim, 8,807.7 tons of ore having a gross value of $191,951.49 were mined and milled, yielding bullion worth $178,801.39, representing an extraction of 93.1 per cent of the gross value of the ore. Figures per ton are as follows: Gross value, $21.7936; tailings loss, $1.4931; and net recovery, $20.3005.

The total operating cost exclusive of depreciation was $63,103.15, or $7.1645 per ton, of which amount $18,539.30, or $2.1048 per ton was for milling.

1,546 feet of development work was performed at a cost of $13,973.15, or $9.04 per foot. * * *

During the year 12,561 tons of ore and waste were removed and trammed to the surface. Of this amount 8,807.7 tons of ore were sent to the mill and 3,753.3 tons of waste placed on the dumps.

During the first half of the year mining operations were confined to the south segment of the Fairview vein and to the fault fissure between the north and south segments of this vein. In this period from January 1 to June 30, 4,023 tons were taken from this section of the mine. During the year 2,700 tons of ore were broken in the fault fissure stope of which 1,200 tons were removed and milled and 1,500 tons left in the stope.

The Kaurohat mine and mill were operated during a part of 1918. Some concentrate, containing gold and silver, was shipped from the flotation plant. This process, it is reported,[2] will be discontinued and cyanidation adopted as giving better results. The Kaurohat and adjoining mines were large producers of silver many years ago, but were developed only by shallow workings and were able to market only the richest ore.

TONOPAH DISTRICT.

Mine production of Tonopah district, Nev., 1904-1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	20	470,122	$1,539,529	7,068,737			$7,364,168
1918	24	501,190	1,287,745	5,929,920			7,217,665
Increase or decrease, 1918		+ 31,068	− 251,784	−1,138,817			− 146,503
Total, 1904-1918		5,284,916	26,260,477	119,896,333	12,113	214,523	99,551,640

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[1] Fairview Round Mountain Mines Co. Ann. Rept. for year ending Dec. 31, 1918.

[2] Min. and Sci. Press, vol. 117, p. 428, Sept. 28, 1918.

In 1918 nearly all the 501,190 tons of ore mined and treated in the Tonopah district yielded gold and silver bullion at cyanidation plants, some of which were equipped for concentration, recovering 303 tons of iron sulphide concentrate containing gold and silver. The mill bullion contained 60,879.14 ounces of gold and 5,746,344 ounces of silver, and the concentrates contained 658.49 ounces of gold and 107,938 ounces of silver. Only 758 tons of silver ore was shipped from the district. The average bullion recovery per ton of ore, old tailings, and sweepings cyanided was valued at $14.43, and the average value of the concentrates per ton was $401.15. The principal producers of ore, named in order of production, were Tonopah Mining, Tonopah Extension, Tonopah Belmont, West End, McNamara, Jim Butler, and Montana Tonopah companies.

Details of the operations of the five principal companies for 1913 and 1917 are given in tabulated form in an article [1] recently published, and the conclusion is reached that the increased costs of operation are almost wholly counterbalanced by the increased value of the silver and gold product and that the increased costs of 1918 will again be just about balanced by the increased selling price of silver.

Mine work at the Tonopah Mining Co.'s property [2] at Tonopah in 1918 consisted essentially in removing old pillars, trying out ends and backs of old stopes, and in the underhand stoping of blocks of ore below old drifts, which had been discontinued when the price of silver was low. This work resulted in the discovery of a considerable quantity of high-grade ore. During 1918 there was shipped to the Belmont mill for treatment 53,279 dry tons of mine ore averaging $18.34 in gold and silver per ton. At the Desert plant of the company at Millers 105,380 dry tons of material was treated, yielding 4,573 ounces of gold and 523,625 ounces of silver. Included in the above was some sand tailing, but the bulk, 102,404 tons in quantity, consisted of ore from the house reject dump, averaging $5.29 per ton in gold and silver, and 1,499 dry tons of mine ore on hand at the mill, averaging $26.73 in gold and silver. Referring to the material treated at the Desert mill, the company report states that

> The mill has operated principally on ore house reject dump ore from January 1, 1918, until November 1, 1918, when the dumps were practically exhausted. During the month of November the mill was run entirely on the treatment of sand tailings. The results did not show a profit, consequently in December the balance of ore on hand at the mill was treated, the ore bins cleaned out, and the mill put in shape for an indefinite shutdown.
>
> The total amount of development work during the year amounted to 4,619 feet. Of this amount 1,625 feet was done from the Silver Top shaft; 1,667 feet from Mizpah shaft, and 1,327 feet from the Sand Grass shaft. This development failed to disclose any new large bodies of ore. Hanging-wall and footwall raises and crosscuts from various veins and stopes opened up several parallel shoots of ore near both the Mizpah and Silver Top shafts.

Dividends paid to stockholders of the Tonopah Mining Co. since April 22, 1905, amounted to $14,575,000, including $375,000 paid in 1918.

The Belmont mine [3] produced 101,048 wet tons of crude ore, from which 12,328 wet tons was culled out as waste and the remaining 88,720 wet tons, containing 3.29 per cent of moisture, or 85,891 dry tons was milled, yielding by cyanidation $1,451,644.92. The average metal content of this tonnage was 0.135 ounce of gold and 13.58 ounces of silver, valued at $16.51 a ton, in 1918, as compared with 0.159 ounce of gold and 16.86 ounces of silver, valued at $16.56, in 1917. Dividends were paid by the company in 1918 amounting to $525,009.39. This company also operates important mines in Canada and California. The company report gives additional information as follows:

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[1] Carpenter, J. A., Effect of the war upon Tonopah mining: Eng. and Min. Jour., vol. 106, p. 601, Oct. 5. 1918.

[2] Tonopah Mining Co. Seventeenth Ann. Rept., for year ending Dec. 31, 1918.

[3] Tonopah-Belmont Development Co. Sixteenth Ann. Rept., for 10 months ending Dec. 31, 1918.

> The average price per ounce received for the silver produced from Belmont ores is 15.62 cents higher than the previous year, and the cost of production is 12.07 cents higher. It seems to be the opinion of those best informed that, although the output of silver may be accelerated somewhat, the price is bound to remain where it is at present, or higher, for several years. During the past nine years your Belmont mine has produced 1,200,000 tons of ore of an average of $20.40 per ton and a gross value of over twenty-four and one-half million dollars, from which net earnings of over twelve and one-half million dollars have been realized, and over nine and one-half million dollars disbursed in dividends. Over three hundred thousand ounces of gold and over thirty million ounces of silver have been produced, the silver being about 5 per cent of the production of the United States during the period. * * *
>
> The total metal recovery from Belmont mine ores was 10,974.439 ounces of gold and 1,076,944.02 ounces of silver. The entire production of gold was sold at an average price of $20.5917 per ounce (10,444.922 ounces in bullion at $20.6718 and 529.517 ounces in concentrates at $19 per ounce). The entire production of silver was sold as produced at an average price of $0.9975 per ounce (970,748.34 ounces in bullion at $1.0023 per ounce and 86,245.68 ounces in concentrates at $0.94228 per ounce).
>
> The loss in mill tailings for the period was $1.225 per ton and metal losses (smelter deductions from concentrates values) was $0.05 per ton. The values realized from mill products (from Belmont ores) was $15.122 per ton. Total net operating costs, inclusive of miscellaneous earnings and of shipping and marketing costs, were $8.581 per ton. The profit per ton was $6.604, or 40.24 per cent of the gross value.
>
> The total operating costs, exclusive of miscellaneous earnings (but inclusive of costs of handling 944 tons of dump ores), was $8.581 per ton, an increase of 11.1 cents per ton over the costs of the preceding year. This increase was chiefly due to the higher per ton cost for development work. Tailings losses were higher by 28.7 cents per ton than in the previous year, but while the percentage of extraction was lower because of an increased tonnage handled by the mill (inclusive of custom ores), part of the increased loss was due to the higher per ounce value of the silver contained in the mill tailings. Total costs and losses, exclusive of miscellaneous earnings, were $9.869 per ton, an increase of $0.461 per ton over the costs and losses of the preceding period. That the costs were no higher, during the period reviewed, wherein labor and other conditions were more severely drastic than ever previously, is, however, most satisfactory.
>
> Within the period the Tonopah mill treated 60,361 tons of custom ores, with a resultant profit of $14,373.76, or an average profit of 23.8 cents per ton. Existing contract prices were modified so that slightly better treatment rates were secured, but the margin of profit continued low. The increased tonnage treated by the mill, has, however, considerably reduced the milling costs from the costs possible with a lesser tonnage and this to an extent which overbalances the somewhat lower recoveries attendant upon the greater tonnages treated.
>
> The scarcity of labor at Tonopah continued for most of the period reviewed and, while not so acute as in some other localities, was most serious. At present mine labor is more plentiful, although experienced miners are still at a premium. There should be shortly, however, an adequate supply of efficient mine labor available because of the present industrial curtailment, and especially because of the great curtailment in copper production, as well as because of miners returning from military service.
>
> The ore reserves indicated as of January 1, 1919, consist of 82,798 tons of positive ore. No estimate is made of probable and possible ores.
>
> During the period ending December 31, 1918, development work has opened up some small new veins, the best of which appears to be the 1,220 vein and has "put on" in several veins, notably the South and Rescue veins, satisfactory tonnages, so that the indicated tonnage of positive ore of January 1, 1919, is greater than the estimate of the same class of ore of March 1, 1918, by some 16,795 tons and is greater than the estimate of March 1, 1918, of all classes of ore, by 6,975 tons.
>
> Aside from the calculated tonnage of positive ore indicated on January 1, 1919, there are very considerable tonnages of low-grade ores, that, with higher silver prices, become commercially profitable ore. * * *

The direct mining cost per ton, of the 87,089 tons of mill ore handled during the period, was $4.564 or $0.126 higher than the previous years' costs. The indirect mining cost per ton was $0.554 or $0.049 less than the similar cost for the year preceding. The total mining costs per ton of ore were $5.118 or $0.075 higher than the $5.043 of the previous year.

The direct mining cost of the 120,213 tons of all rock (ore and waste) broken was $3.697 per ton, an advance of $0.274 per ton over the similar cost of the preceding year. The indirect mining cost per ton of ore and waste was $0.40 as compared with $0.41 in the year previous.

The direct development cost per ton was $1.069, an increase of $0.057 per ton over the $1.012 of the preceding period. The direct stoping cost was $3.495, an increase of $0.067 as compared with the cost of the previous year.

Rates of wages and prices paid for supplies were considerably higher than in the previous year (the wage rates prevailing throughout the 10 months' period having been effective for but one-half of the previous year) and the decreased efficiency of labor became more marked with its scarcity. The labor costs were kept within bounds only by the extension to more of the mining work of the contract system, under which, while higher average daily wages than the base rates were paid, efficiencies improved to such an extent as to reduce costs from those attainable by the non-contract system.

The Tonopah Extension Co.[1] mined and milled 114,921 dry tons of ore, from which were recovered 1,367,439.74 ounces of silver and 13,142.837 ounces of gold, valued in all at $1,652,031.42. The average value of the ore milled was $15.449 a ton, which, with metal losses in tailing deducted ($1.074), amounted to $14.375 a ton, representing a metal recovery of 93.05 per cent. The average price per ounce received for silver was $1.00944 and for gold $20.6718. The mining cost, including all development work, was $4.804 a ton; milling, $3.447; marketing cost $0.237 a ton; metal losses in tailing, $1.074; or a total cost of $9.562 a ton, and a total profit per ton of $5.887. From the company's report the following is taken:

The increase shown in the cost of milling is due almost entirely to increase in cost of crushing and sliming. The inferior quality of iron, steel, and pebbles used, together with the increased cost of these materials, have added greatly to our milling costs. The consumption of cyanide per ounce of bullion was 0.1716 pound.

The consumption of zinc per ounce of bullion recovered was 0.0549 pound.

The average fineness of bullion produced was 944.9 silver and 9.05 gold.

Our recovery during the year shows an increase of 2.54 per cent.

The West End mine[2] produced 50,195 dry tons of ore in 1918, against 45,910 tons in 1917. All the ore produced in 1918 was treated by cyanidation, yielding 8,675.67 ounces of gold and 826,576.67 ounces of silver, valued in all at $990,184.93, or an average value per ton of $19.73. The treatment charge, including depreciation, was $3.34 a ton; loss in milling, $1.30 a ton; marketing and sampling, $0.29 a ton; cost of ore to mill bins, $6.79 a ton (includes depreciation and development charges); and total costs, $11.72. The net profits of mining and milling the ore from the West End mine were $8.01 a ton. Including the custom ore, the West End mill treated altogether 66,518 tons of ore, with a gold extraction of 94.3 per cent and of silver, 91.95 per cent. The cyanide consumption was 0.131 pounds of sodium cyanide per fine ounce of bullion; zinc consumption was 0.053 pound per fine ounce of bullion.

At the Jim Butler mine[3] in 15 months, from October 1, 1917, to December 31, 1918, there was produced 27,352 dry tons of ore, reported in the company's printed report as follows:

The total production of the property by company operation was 32,256 wet tons of crude ore, from which there was culled out as waste 3,684 wet tons (11.42 per cent), the resultant tonnage shipped aggregating 28,572 wet tons containing 4.27 per cent moisture, or 27,352 net dry tons. The average metals content of this production was 0.249 ounce of gold and 21.97 ounces of silver per ton, as compared with the 0.31 ounce of gold and 26.94 ounces of silver of the previous period. The total metallic content of the ores mined was 6,798.435 ounces of gold and 600,806.02 ounces of silver, less than the similar figures of the preceding year by 4,818.518 ounces of gold and 416,939.78 ounces of silver. The average price received for the gold produced was $19 per ounce and for the silver produced 90.825 cents per ounce, the price received for the silver being higher by 10.216 cents per ounce than that received in the previous year.

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[1] Tonopah Extension Mining Co. Ann. Rept. for year ending Mar. 31, 1919.
[2] West End Consolidated Mining Co. Twelfth Ann. Rept., for year ending Dec. 31, 1918.
[3] Jim Butler Tonopah Mining Co. Ann. Rept. for 15 months ending Dec. 31, 1918.

The gross value of the ore produced by company operation was $724,009.13, or an average per ton of $26.15, as compared with the gross value of the previous year of $1,052,600.67 and the average per ton value of $26.12. The total operating costs and losses applicable to ores from Butler ground were $15.75 per ton as compared with $13.73 per ton during the previous year, the increase being due to increased mining and development costs. The total operating costs were $13.61 per ton, or an increase of $1.67 per ton over the similar costs of the preceding year. Ore stoping costs were $6.46 per ton, this increase as compared with the $4.11 per ton of the previous year having been due to the character and condition of the veins stoped. Development costs per ton were $1.75 as compared with $1.06 for the previous year. Transportation costs were reduced, by reason of the shipments to the Belmont mill at Tonopah rather than to the mill at Millers, from the 71 cents for the previous period to 53 cents per ton. Treatment charges were reduced, on account of more favorable milling contracts, from $5.33 per ton during the previous year to $3.98 per ton. Mill deductions (losses in tailings and shipping and marketing of products) were increased 35 cents per ton, from $1.79 in the previous year to $2.14 per ton, a greater part of the increase being due to the higher values of the silver lost in tailings. Combined treatment charges and mill deductions were, however, less by $1 per ton than during the previous year. The percentage of profit during the period was 40.92 per cent as compared with 45.52 per cent during the previous year.

Tybo district.—The property of the Louisiana Consolidated Co. was operated in 1918 and some milling ore was concentrated in a mill on the property and produced lead concentrate containing gold and silver. Some lead ore of shipping grade was also produced.

Washington district.—Some silver ore was shipped from the Washington group of claims. The property is opened by a vertical shaft.

ORMSBY COUNTY.

Three deep-mine producers reported 367 tons of ore and old tailings, which was 330 tons more than was produced in 1917 from 1 mine. The total average value per ton decreased from $41.73 in 1917 to $10.93 in 1918, and the gold and silver value from $39.05 to $10.68 per ton. From one property there was produced 37 tons of ore of smelting grade, containing silver, copper, and a little gold.

Carson River district.—Small quantities of gold and silver bullion and mercury have been produced in the past by the operation of small cyanidation plants and placering machines in the attempt to save the amalgam of the old mills along Carson River which once operated on Comstock ores.

Although no report was made to the Survey of any production in 1918, the Unevida Gold Mining Co. is reported to have put in an equipment according to the following article [1] recently published:

> Placer mining is recovering amalgam containing gold and silver from the bed of Carson River, 6 miles below Empire, where bends in the river have caused to be deposited in the form of bars large quantities of tailing from the Santiago, Vivian, Merrimac, Brunswick, Morgan, and Mexican mills, which treated the product of the Comstock bonanzas. In the earlier period the ore had a greater gold than silver content, in the proportion of 60 gold to 40 silver. A tremendous quantity of quicksilver was used in the pan-amalgamation process, and all of this was finally lost in the tailing,

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[1] Recovering gold and silver from old tailing: Min. and Sci. Press, vol. 117, p. 497, Oct. 12, 1918.

while extraction of the metals was rarely above 65 per cent. Sumps are dug in the sand in the river bed, which contains many boulders, precluding the use of dredges, and a 2-stage, 3-inch, motor-driven centrifugal pump delivers the water and sand under a pressure to another sump, where it is taken by a 4-inch Byron Jackson centrifugal pump, which raises the gravel 16 feet to the sluice. The sluice is 65 feet long, lined with ordinary Hungarian riffles and cocoanut matting under expanded metal. Five feet from the end of the sluice, one-eighth mesh screens are used as a grizzly to carry the fine material to a side sluice, thus saving the concentrate on an undercurrent. Panning reveals some native quicksilver and quantities of coarse lumps of amalgam. Tests appear to have proved the existence of quantities of valuable material in the river bed, and production is said to be a question of mechanical methods. Tests have been made at the Mackay School of Mines at Reno, and the best results have been obtained in washing in sluices. Bedrock has not been reached, and a coarse concentrate recovered from the first tests assayed $15,166 gold and silver, and 20 per cent mercury. Fines from this sample assayed $25,248 gold and silver, and 17 per cent mercury; while third-grade fine assayed $1,000 in precious metals. Amalgam recovered separately from the fine had a value of $1.05 per ounce.

Voltaire district.—Silver ore containing a little copper was produced from the Panama Canal property and shipped to a smelter in California. This ore was taken out in development work, which continued during 1918.

STOREY COUNTY.

Mine production in Storey County, Nev., in 1917 and 1918.

Year.	Number of producers.	Ore. *Short tons.*	Gold.	Silver. *Fine ounces.*	Total value.
1917	33	59,805	$360,875	243,072	$561,166
1918	29	95,051	518,154	321,636	839,790
Increase, 1918		35,246	157,279	78,564	278,624

The output of ore was 35,246 tons more than in 1917, and the total average value per ton, all of which was for gold and silver, decreased from $9.38 in 1917 to $8.83 in 1918. The entire output came from Comstock district, and there was a distinct increase in both gold and silver.

Comstock district.—Twenty-nine producers reported an output of 95,051 tons of ore, containing $518,154 in gold and 321,636 ounces of silver, valued in all at $839,790, or an average value per ton of $8.83. Nearly all of the ore, and some old tailings, were treated at milling plants, principally by cyanidation, yielding 24,405.19 ounces of gold, valued at $504,500, and 312,275 ounces of silver. There was also 128 tons of concentrate produced at these plants, valued at $16,762, or an average value per ton of $130.95. Only 77 tons of ore was shipped to the smelters from the district. This ore contained $2,760 in gold and 3,493 ounces of silver and was valued in all at $6,253, or an average of $81.21 per ton. In 1917 there were 33 producers with an output of 59,805 tons of ore, valued at $561,166, or an average value per ton of $9.38. The principal producers in 1918 were the Union Consolidated, Consolidated Virginia, Comstock Leasing Co., working the Chollar and Potosi mines, Silver Hill, Dayton Placer Recovery Corporation, working on tailings, Mexican, Ophir, Andes, and Jacket-Crown Point-Belcher properties.

The reopening of the lower levels of the Comstock lode is an interesting chapter in the mining history of the West. It is reviewed in a recent article,[1] part of which follows:

> The development of new high-grade ore bodies in the lower levels of the Northend mines of the Comstock lode at Virginia City, Nev., as a result of drainage to the 2,900-foot level, establishes proof of the persistence of payable ore at depth. A large area is now drained and reopened for mining.
>
> The complete reopening of the lower level of the Northend mines, through the Union shaft, after being filled with water for 33 years, was marked by the extraction of payable ore on the 2,700-foot level in July, 1917. In September of that year development was in progress on the 2,900-foot level. Since the middle of July, 1917, new ore has been disclosed and developed from the 2,300-foot down to the 2,600-foot level. In the middle of last September important disclosures were made of ore averaging in excess of $30 per ton, one on the 2,300-foot level and one in a new winze at a depth of 26 feet below the 2,700-foot level. The average payable ore mined in other parts of the upper level ranged from $12 to $37 per ton, and has been almost constant during the last three years, with frequent occurrences of ore assaying $60 to $70 per ton. Low-grade ore has also been discovered in prospecting.
>
> The active resumption of mining in the lower levels followed close upon the draining of the mines by electrically driven pumps lifting through the C. & C. shaft to the Sutro tunnel. This accomplishment was the result of nine years of patient, arduous labor. The operators controlling the drainage and development of the Northend and the North Middle mines comprise the Sierra Nevada Mining Co., Mexican Gold & Silver Mining Co., Union Consolidated Mining Co., Ophir Silver Mining Co., and the Con. Virginia Mining Co. The United Comstock Pumping Association, with W. G. Morrow, as president, Whitman Symmes, mining engineer, and T. F. McCormick, superintendent, is a separate organization, which carries on the drainage work and apportions the expenses among the different mines. The Slossen-Symmes interests control the Union, Mexican, Ophir, and Con. Virginia, and cooperate with the Sierra Nevada, of the Northend mines. The pumping in progress or to be undertaken is handled by the United Comstock Pumping Association. * * *
>
> Unwatering the Northend mines was started in 1898. In the five years following, the mines were drained and the C. & C. and Union shafts reopened to the 2,000-foot level. In the period of 1912-1914 draining and exploration proceeded to the 2,500-foot level. The complete drainage undertaken by the present operators in the Sierra Nevada, Union, Mexican, Ophir, and Con. Virginia to their respective lowest working levels was accomplished by the end of June, 1917, and exploration was in progress in every available part of the Northend mines by the end of July. Development followed closely, and in practically all the levels explored ore has been disclosed. Exploration has not extended north of the Sierra Nevada shaft nor into the southern half of the Con. Virginia. The present purpose is to continue exploration and development within the area between the Sierra Nevada shaft on the north and the C. & C. shaft on the south. With the unwatering of the North Middle mines, the extension of Northend exploration will proceed to the south.
>
> That there are payable ore bodies below the 2,900-foot level is not improbable. In fact, ore is said to have been disclosed in 1884 in the 3,100-foot level of the Mexican and in the deep winze below the 3,100-foot level. This was during the progress of the early mining in the Mexican, and the work was done in 1884, the year the mine was closed, the upper working being kept open for air. The 3,100-foot level and the deep winze are shown on the map by broken lines, indicating that the workings are closed. They could be reopened and the reports of ore discovered investigated, but there is now sufficient area and depth of ground drained and available above the 2,900-foot level to assure a long period of development and possible production in the Northend mines.

WASHOE COUNTY.

Twenty-one producers in Washoe County reported 2,091 tons of ore in 1918, 729 tons less than was produced by 31 producers in 1917. The total average value per ton decreased from $26.21 in 1917 to $23.27 in 1918, and the gold and silver value in the ore increased from $16.15 to $17.75. The greater part of the ore was milled and yielded lead concentrate, containing silver and having an average value per ton of $145.03. At gold and silver mills, 553 tons of ore treated produced gold and silver bullion containing $10,740 in gold and 1,399 ounces of silver, with an average value per ton of $21.95.

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[1] Eddy, L. H., Mining lower levels of the Comstock lode: Eng. and Min. Jour., vol. 105, pp. 1029-1032, June 8, 1918.

Leadville district.—Lead ore was treated in the concentration mill on the Tohoqua property, yielding lead concentrates, containing principally silver, which were shipped to the smelter. The mine and mill were operated nearly all the year.

Peavine district.—Five producers reported 32 tons of ore, all of it containing copper. The total output was valued at $4,746, or an average value per ton of $148.31.

Pyramid district.—A small lot of copper ore was shipped to the smelter from the Big Buck claim.

White Horse district.—Thirteen producers reported 562 tons of ore, containing $11,200 in gold and 1,596 ounces of silver, valued in all at $12,796, or an average value per ton of $22.77. All the ore, with the exception of 9 tons shipped directly to the smelter, was milled and yielded gold and silver bullion recovered principally by the amalgamation process in the Slipp custom mill. Production was reported from the Springfield Nevada, Renegade, Keystone, and Monitor properties.

WHITE PINE COUNTY.

Mine production in White Pine County, Nev., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	47	4,474,253	[a]$769,833	[a]186,574	93,786,328	2,437,908	....	$26,736,898
1918	48	4,534,662	686,856	189,210	92,538,218	4,573,941	652,885	24,117,169
Increase or decrease, 1918	......	+60,409	−82,977	+2,636	−1,248,110	+2,136,033	+652,885	−2,619,729

[a] Includes placer production.

Forty-eight operators, 2 of which produce most of the ore in White Pine County, reported the production of 4,534,662 tons of ore, or 60,409 tons more than was produced in 1917, as reported by 44 operators. The total average value per ton decreased from $5.98 in 1917 to $5.32 in 1918, and the gold and silver value in the ore from 21 cents to 19 cents. The bulk of the ore, 4,442,570 tons, was treated at concentration mills and yielded 521,612 tons of concentrates nearly all of which (521,282 tons) was copper concentrate, and the remainder (330 tons) was lead concentrate. The total average value per ton of all concentrates was $41.02. There was 91,518 tons of ore directly smelted, which contained $13,305 in gold, 93,624 ounces of silver, 9,057,626 pounds of copper, 4,242,036 pounds of lead, and 652,885 pounds of zinc, valued in all at $2,704,760, or an average value per ton of $29.55. There was 371 tons of old tailings and slag smelted, which yielded gold, silver, copper, and lead, and a small quantity of copper ore leached. Gold and silver bullion was produced from 103 tons of ore treated at milling plants. No reports were received from placer operators in 1918. In 1917 gold valued at $1,212 and 10 ounces of silver were reported.

Aurum district.—Some sulphide copper ore, containing silver, was shipped to the smelter from the Lucky Deposit property. The Muncy Creek property yielded some oxidized ore. This property is being equipped with a reduction plant, which is expected to be in operation during 1919.

Cherry Creek district.—The principal part of the output was from the property of the Cherry Creek Silver Mining Co. and consisted of silver ore, containing a little gold. This production, with that of five other operators in the district, made an output of 946 tons of ore, containing $887 in gold, 27,680 ounces of silver, and 10,301 pounds of lead, valued in all at $29,298, or an average value per ton of $30.97.

Duck Creek district.—A small quantity of lead ore from the Lead Queen and Lostwego properties was shipped in 1918.

Eagle district.—Lead ore was shipped from the April fool No. 1 and Red Hills group in 1918.

Granite district.—Various small lots of bullion, probably recovered from small amalgamation tests on free gold ores, were reported by merchants in the district.

Hunter district.—Some ore containing principally silver with some copper and lead, was shipped from the Hunter property, owned by the Vulcan Mining Co.

Osceola district.—Small quantities of gold bullion and one lot of lead ore shipped to the smelter were reported from three properties in the district.

Robinson (Ely) district.—The geology of the Robinson (Ely) district is described in a paper[1] issued by the Survey in 1917. There were 21 producers in 1918, but the bulk of the ore came from two mines, the Nevada Consolidated and the Consolidated Coppermines. The following table gives a comparison of the production for the last two years and the total output beginning with the year 1904:

Mine production in Robinson district, White Pine County, Nev., 1904–1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	16	4,467,709	$765,376	131,825	93,627,420	512,862	....	$26,478,391
1918	21	4,520,936	683,823	104,615	92,419,990	479,139	652,885	23,709,607
Increase or decrease, 1918		+ 53,227	− 81,553	−27,210	−1,207,430	− 33,723	+652,885	−2,768,784
Total, 1904–1918		32,722,753	5,335,940	951,040	737,360,294	2,484,473	695,536	148,739,272

From the Nevada Consolidated mine[2] 2,711,743 tons, or 67 per cent, of the sulphide ore was mined and shipped to the concentrator from the shovel pit, and 1,316,144 tons, or 33 per cent, from Ruth underground workings. These ores contained 1.334 and 1.857 per cent of copper, respectively. In addition to this tonnage of concentrating ore, 14,811 tons of siliceous carbonate ore, assaying 2.99 per cent of copper, was mined and shipped to the smelter as flux, and 5,960 tons of the same class of ore, assaying 2.84 per cent of copper, was shipped to the smelter from stock piles. There was also mined for the Consolidated Coppermines Co. 193,093 tons of sulphide concentrating ore, assaying 1.545 per cent of copper. Further details taken from the company's annual report follow:

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[1] Spencer, A. C., The geology and ore deposits of Ely, Nev.: U. S. Geol. Survey Prof. Paper 96, 1917.

[2] Nevada Consolidated Copper Co. Twelfth Ann. Rept., for year ending Dec. 31, 1918.

> The net production from your company's mines for the year amounted to 76,607,062 pounds of copper, as compared with 82,040,508 pounds for the year 1917. This decrease of 5,400,000 pounds, nearly 7 per cent is due in part to the fact that a considerable proportion of the mill and smelter was given over to the treatment of custom ores under contract obligations, but chiefly to the lower recoveries which obtained throughout the year. This lowered extraction was the result, primarily, of the effort sustained throughout the year to maintain tonnage and production in the face of unprecedented operating difficulties of every nature, especially in the way of inadequate and unsatisfactory working forces and supplies.
>
> Despite these adverse conditions, the total tonnage of company and custom ore treated during the year compared favorably with that of the previous year. In 1917 a total of 4,239,500 tons of ore, or an average of 11,780 tons daily, was milled, as compared with 4,192,600 tons, or an average of 11,650 tons daily in 1918, an almost negligible decrease. The total copper contents of the concentrates produced, however, showed a decrease of approximately 5 per cent as a result of deficient recoveries. * * *
>
> Including toll copper produced from ores of the Consolidated Coppermines Co. amounting to approximately 17 per cent of the smelter production for the year, the total output of the smelter for 1918 was slightly in excess of that of 1917. The average monthly production for the year 1917 was 7,608,300 pounds, whereas in 1918 output was maintained at an average monthly rate of 7,649,900 pounds. While this increase is not large, it is sufficient to reflect the advantage of improvements in machinery, plant and equipment installed in recent years, as offsetting to an important degree the operating difficulties of the year under discussion.
>
> The treatment of 11,650 tons of ore daily during the year 1918, when compared with pre-war years, shows an increase of over 20 per cent. The average daily capacity of the concentrator up to 1915 was less than 10,000 tons of ore. During the period of the war, in order to maintain, and, if possible, increase production, the daily tonnage capacity of the property was enlarged by alterations, improvements, and betterments in the equipment at the mine, mill, and smelter to such an extent that only minor balancing of certain departments is necessary to perfect an economic capacity of upward of 13,000 tons of ore daily.
>
> The most important improvement completed during the year is the coal pulverizing plant which serves the reverberatory furnaces. The performance of this plant has been satisfactory and its installation has proven fully justified by the scarcity and increased cost of fuel oil as formerly used.
>
> The new coarse crushing plant at the concentrator in service during the year has fulfilled expectations in relieving the fine crushing departments and reducing costs.
>
> At the mines, ore tracks and haulage-way connections have been completed on several benches between the Eureka and the Liberty pits. Adverse and heavy grades, spiral haulage-ways and other objectional features in the mining and transportation of ores from the lower benches in the pits, have to a great extent, been overcome by these connections, which bring both pits practically under one trackage system, and also permit of the laying out of ultimate and permanent ore ways into a steam shovel area. * * *
>
> The net profits for the year, after deducting depreciation, plant abandonment, and donations, one of $50,000 to the Red Cross and one of $100,000 to the United War Work Fund, amounted to $3,252,070.53. Compared with the year 1917, when net profits totaled $9,408,892.72, the decrease is $6,156,822.19. This difference is due to three prime factors. First, increased operating costs over the previous year of 4.92 cents per pound of copper; second, a decrease of 2.7 cents in the price of copper upon which earnings were based; and third, the reduced production of copper. The price at which earnings for the year 1917 were computed was 23.75 cents per pound, while the average basing price for 1918 was 21.049 cents per pound of copper. The average price received for copper actually delivered during the year 1918 was 24.572 cents per pound.
>
> The increased quantity and proportion of unsold copper on hand at the close of the year and taken into account at the 13.5 cents as usual, explains the low average basing price. The copper in inventory sold but not delivered is carried at the actual sales price of 24.5 cents. A resulting average of 13.938 cents is the price at which all copper undelivered at the end of the year is carried into inventory. * * *
>
> The cost of producing refined copper, including the customary charge for depreciation of plant and equipment, necessary reserves for taxes set up during the year, and all

fixed and general expenses, and after crediting miscellaneous income, was 16.60 cents per pound as compared with 11.68 cents per pound for the previous year, 8.86 cents per pound for the year 1916, and 8.68 cents for the year 1913 as a strictly prewar example. This is an increase of 42 per cent over 1917 costs, 87 per cent over 1916 costs, and 91 per cent over 1913 costs.

Reserves for depreciation and Federal taxes charged into costs for the year amounted to 1.84 cents per pound. If these items were treated as charges against income, instead of against costs of production the per pound cost for 1918 thus derived and after crediting all miscellaneous income would be 14.76 cents, as compared with 10.23 cents for 1917 and 7.73 cents for 1913, calculated in the same way.

Distributions to stockholders during the year amounted to $6,498,235.25. The total of such disbursements from the beginning of operations up to the end of 1918 has been $42,269,838.35. The earned surplus, which at the end of the year 1917 amounted to $13,180,525.97, was reduced during the current year to $9,934,361.25 The net assets at December 31, 1918, as per detailed statements rendered by auditors, were $11,436,903.69. This financial outcome is the result of treating 30,000,000 tons of ore produced by the mines from the beginning of operations, out of a total developed to date of over 98,500,000 tons, or only about 30 per cent of the total developed tonnage. It is known that extensions of ore bodies exist and are available for development. * * *

The total steam shovel mining costs of concentrating ores for the year were 41.69 cents per ton, of which 15.81 cents represent taxes, leaving 25.88 cents as the operating costs, which include all overhead expense except the item of taxes. For 1917 the comparative operating costs were 18.9 cents and for 1916, 12.42 cents per dry ton mined. The year's costs, therefore, show an increase over 1917 of 37 per cent. The total mining cost, including taxes, and stripping suspense charge of 34.9 cents was 76.62 cents, as against 63.38 cents for 1917 and 53.7 cents for 1916.

Overburden removal costs in 1918 were 41.20 cents per yard as compared with 34.43 cents for 1917, 30.09 cents for 1916, and 34.48 cents for the whole period of operation. * * *

Ruth underground mining costs in 1918 were $1.2855 per dry ton, of which 30.47 cents was the charge for taxes, leaving a direct mining cost of 98.08 cents. In 1917 Ruth mining costs were $1.0251, of which 19.99 cents was the tax charge, leaving a direct mining cost of 82.52 cents. To this mining cost must be added the development suspense charge of 30 cents and the suspense construction charge of 5 cents per ton to obtain the total mining cost, including taxes for respective years. * * *

The total Nevada Consolidated ore tonnage milled during 1918 was 3,999,526 tons, averaging 1.506 per cent copper, the actual mill extraction being 67.28 per cent, the ratio of concentration 8.22 to 1 and the per cent of copper in the concentrates is 8.33 per cent. The indicated extraction for the year was 69.95 per cent and some of this difference between the indicated and actual extraction will probably be later recovered in the concentrates tonnage in storage as the smelter did not reduce to blister copper the total mill production in concentrates and much of this tonnage was high in moisture and difficult of accurate inventory. * * *

Total milling costs for the year were 93.1 cents, which includes all overhead and taxes, but does not include plant depreciation, as compared with 74.8 cents for 1917, showing an increase of 24.5 per cent. Mill tonnages treated in 1918 and copper produced in concentrates by quarters, as compared with 1917, were as follows:

	1917		1918	
	Tons milled.	Copper in concentrates.	Tons milled.	Copper in concentrates.
		Pounds.		*Pounds.*
First quarter	940,916	20,036,627	942,751	18,664,727
Second quarter	1,021,990	21,912,537	1,067,212	22,734,755
Third quarter	1,014,031	21,615,058	1,003,898	19,801,288
Fourth quarter	1,087,158	23,270,049	985,665	19,837,007
	4,064,095	86,834,271	3,999,526	81,037,777

In addition to the above-stated Nevada Consolidated tonnage, 193,093 tons of sulphide ore averaging 1.545 per cent copper were milled for account of Consolidated Coppermines Co. and the concentrates derived therefrom were smelted under existing milling and smelting contracts. * * *

Four reverberatory furnaces were in operation throughout the year and the fifth, which had not been in service since 1914, was rebuilt and put into commission in August. Labor shortage prevented the continuous operation of five furnaces until December, when all were again put in use. The total charge smelted in reverberatories for the period was 654,650 tons, as compared with 741,424 tons in 1917. Of this total 42,991 tons of oxidized ores, 19,482 tons of custom concentrates produced at the company's mill, and 14,904 tons of concentrates other than those so produced were smelted during the year.

The property of the Consolidated Coppermines Co.[1] produced ores in 1918 containing 15,768,481 pounds of copper, 4,337.85 ounces of gold, 17,414.78 ounces of silver, 768,101 pounds of zinc, 178,451 pounds of lead, and 323,170 pounds of manganese. Part of this production was from certain of the scattered outlying properties operated by lessees. Of the 496,793 dry tons of ore mined, 246,417 tons came from the Morris-Brooks mine, supplying ore for the Kimberly concentrator—53,518 tons of direct smelting ore from the Alpha mine, 193,749 tons from the Ora claim in Liberty Pit, where ore is mined by steam shovels by the Nevada Consolidated Copper Co. and concentrated at its Steptoe works, and 3,109 tons of ore from various leases. Concerning some of the developments and future of the mines, the company's report contains the following:

> Since the Alpha was reopened in 1917 there has been mined a total of 82,917 tons of ore with an average grade of 7.67 per cent and from which was produced 12,050,461 pounds of copper. It is estimated that present exposed faces will produce over 100,000 tons of ore that will average at least 8 per cent grade. There has therefore been opened up by the development work done, something over 180,000 tons of ore, averaging about 8 per cent copper, This lies in an area of about 650 feet maximum length, 200 feet maximum width, and has been developed nearly 500 feet vertically.
>
> Except on the 1,200-foot level, this area is not fully explored and further work may add materially to the estimates of ore contained within its boundaries.
>
> The present depth of the main hoisting shaft is 1,440 feet. It is planned to sink this in the near future at least 200 feet deeper; also to extend exploration work laterally, both east and west. As stated above, these ores lie near a limestone-porphyry contact, of which a length of several thousand feet is included within the properties of the company. Excepting at the Alpha mine this contact has never been prospected at depth, but the results of the work here justify the belief that other ore zones of the same kind will eventually be discovered as the contact is more thoroughly explored.
>
> The Morris-Brooks mine, opened up to work one of the low-grade disseminated porphyry ore bodies, had been developed to operate by branch raise caving, a system that has shown very low costs in mines in other districts of more or less similar character. When it was decided to put this mine into operation, the old concentrator at Kimberly was also remodeled and equipped to use flotation. It was realized that this operation would not be permanent, as owing to the location and power equipment of the concentrator, as well as the limited capacity of the mining and milling plants, low production costs could not be expected. However, as the price of copper was high and expected to continue high for a considerable length of time, it seemed to be a good opportunity to run the mine and mill during the period of high prices, securing what revenue might be obtained from the operations, but especially to accumulate data on the efficiency of the mining system and to work out the best method for concentrating the ores. The operations did not earn a profit for the period for which they were conducted, for while the cost of supplies and labor increased—owing to war-time condition—far beyond what had been anticipated, the selling price was fixed by Government action at considerably below the market price when the mill was started up in 1917.

Ward district.—Lead ore, containing silver and a little copper, was shipped from the Ward mine, operated by the Nevada United Mines Leasing Co. The property is opened by two adits, 2,500 and 1,500 feet, respectively.

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[1] Consolidated Coppermines Co. Ann. Rept. for year ending Apr. 30, 1919.

White Pine district.—The Grand Prize property yielded some oxidized copper-lead ore and a small quantity of oxidized lead ore of shipping grade containing silver and a little copper. At the Great Valley mine some lead ore was concentrated in a hand jig and the concentrate shipped to the smelter. Reports from the Nevada mine gave the shipment of a number of lots of oxidized lead ore and a little copper-lead ore, containing principally silver. The total output of the district amounted to 2,848 tons, containing $293 in gold, 16,742 ounces of silver, 20,049 pounds of copper, and 897,500 pounds of lead, valued in all at $85,710, or an average value per ton of $30.09.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN MONTANA.

(MINES REPORT.)

By C. N. GERRY.[1]

PRODUCTION.

GENERAL STATEMENT.

The value of the production of gold, silver, copper, lead, and zinc from 493 mines in Montana in 1918 was $121,405,569. This total represents an increase of $11,256,187, or more than 10 per cent over the output of 1917, when 617 mines made an output valued at $110,149,382. There was considerable decrease in the output of gold, but large increase in the other metals and in the quantity of ore mined and treated. The production of copper and zinc was less than that of 1916, but silver and lead established new records for the State. Silver Bow County, which includes the Butte or Summit Valley district, continued to produce the bulk of the silver, copper, lead, and zinc of the State, though most of the gold is mined in other districts. Dividends declared by six mining companies in 1918 amounted to $19,455,472. The corresponding total for 1917 was $23,717,134. Most of the dividends were paid by the Anaconda Copper Mining Co., assisted by its subsidiary companies. The surplus remaining after dividends were paid for 1918 was $66,232,484.

Mine production of gold, silver, copper, lead, and zinc in Montana in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917...........	617	6,307,164	$3,517,253	13,128,142	274,462,574	21,951,220	186,259,331	$110,149,382
1918...........	493	7,823,967	3,104,764	16,797,479	323,174,850	37,135,875	209,258,148	121,405,569
Increase or decrease, 1918..	....	+1,516,803	− 412,489	+3,669,337	+48,712,276	+15,184,655	+22,998,817	+11,256,187

[a] Includes placer production.

ORE.

The total quantity of ore sold or treated was 7,823,967 tons, an increase of 1,516,803 tons, or 24 per cent, but the total average value per ton decreased from $17.39 in 1917 to $15.47 in 1918. The average value per ton of the gold and silver contained in this ore increased from $2.20 to $2.49. More than 76 per cent of the ore (5,961,753 tons) was concentrated, a little more than 2 per cent (175,036 tons) was treated in gold and silver mills, and only about 6 per cent (478,860 tons) was shipped directly to smelters. The remainder, more than 15 per cent, consisted of old tailings, which were either milled or leached. Mines in Silver Bow County produced 7,394,038 tons of ore and tailings, or 95 per cent of the total output. Copper ore represented 82 per cent of the total, lead-zinc ore nearly 14 per cent, siliceous ore less than 4 per cent, and other kinds less than 1 per cent.

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[1] Valuable assistance, especially in the compilation of statistical tables, was rendered by Bessie N. Patchell, of the United States Geological Survey.

The total output of dry or siliceous ore in the State was 286,522 tons, of which 234,663 tons was classified as gold ore, 233 tons as gold and silver ore, and 51,626 tons as silver ore. The largest part, or 168,544 tons, or dry or siliceous ore, together with 21,575 tons of old tailings, was treated by cyanidation, and 6,492 tons was treated by amalgamation. There was 68,372 tons of siliceous ore shipped directly to smelters for treatment, and 2,219 tons was treated at concentration mills. Phillips, Lewis and Clark, Fergus, and Granite counties were the largest producers of strictly siliceous ores. Deer Lodge County produced chiefly oxidized iron ore mined in the Georgetown district; it contained more than 20 per cent excess iron and a little gold and was used as a flux at the smelter. Sulphide iron ore, containing more than an ounce of gold per ton, was mined in Broadwater County, near Radersburg, and also in Madison County. The siliceous ore had an average assay per ton of $5.82 in gold, 3.59 ounces of silver, and a few pounds of copper and lead.

The output of copper ore was 6,412,941 tons, of which 4,885,328 tons was of milling grade and produced 1,738,462 tons of concentrate averaging 34 cents in gold and 5.14 ounces of silver per ton and 7.71 per cent of copper and having an average value per ton of $43.58. The copper ore of shipping grade amounted to 384,007 tons, largely sulphides, containing 21 cents in gold and 3.59 ounces of silver per ton and 4.58 per cent of copper and having an average value of $26.44 a ton. From 253 tons of copper-lead ore there were 166 tons milled and 54 tons of copper-lead concentrate produced, which averaged $9.41 in gold and 33.07 ounces of silver per ton, 4.41 per cent of copper, and 13.88 per cent of lead and had an average value per ton of $83.98.

The output of lead ore was 31,423 tons, most of which, or 26,284 tons, was shipped directly to the smelters. The first-class ore contained $3.70 in gold and 26.63 ounces of silver per ton, 0.29 per cent of copper and 11.39 per cent of lead, and had an average value per ton of $47.94. Lead concentrates (11,432 tons) were made from lead ore and lead-zinc ore and averaged $3.32 in gold and 23.15 ounces of silver per ton, 0.26 per cent of copper, and 41.98 per cent of lead. The average value per ton of all lead concentrates was $87.39.

Zinc ore (1,873 tons) was all milled, except 72 tons shipped as first-class ore. Zinc concentrates recovered from zinc ore and lead-zinc ore aggregated 190,254 tons, averaging 64 cents in gold and 14.11 ounces of silver per ton, 0.57 per cent of copper, 1.51 per cent of lead, and 43.14 per cent of zinc, the total average value per ton being $98.24. The lead-zinc ore amounted to 1,090,955 tons, and nearly all of it was milled and produced lead concentrate, zinc concentrate, and lead-zinc concentrate—the first two items have been already given above. The lead-zinc concentrate recovered from lead-zinc ore aggregated 108,952 tons, containing $1.03 in gold, 14.42 ounces of silver per ton, 1.71 per cent of copper, 7.01 per cent of lead, and 20.69 per cent of zinc, the average value per ton being $71.49.

Ore and metals produced in Montana in 1918.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper	Lead.	Recoverable zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	86		19,167.72	3,166			
Dry or siliceous ore	206	286,522	80,613.50	1,028,443	251,764	33,264	
Copper ore	76	6,412,941	32,464.51	10,521,219	316,740,920		
Lead ore	134	31,423	4,747.38	707,757	178,809	6,537,297	
Zinc ore	6	1,873	30.82	2,556	13,867	3,214	199,198
Copper-lead ore	4	253	32.02	2,304	10,086	81,775	
Lead-zinc	15	1,090,955	13,137.01	4,532,034	5,979,404	30,480,325	209,058,950
		7,823,967	150,192.96	16,797,479	323,174,850	37,135,875	209,258,148

As indicated above, a large number of mines produced siliceous ore and lead ore, and the siliceous ore is more generally distributed over the State. The copper ore, however, was the most valuable product, being valued at $89,427,327 in 1918; the lead-zinc ore was valued at $27,468,980, and the siliceous ore at $2,759,420.

Ore sold or treated in Montana in 1918, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total
Beaverhead	402	415	3,763		3		4,583
Broadwater	354	6,627	393				7,374
Cascade	357		4,258				4,615
Deer Lodge	36,824	61					36,885
Fergus	37,453		17				37,470
Granite	26,457	405	89				26,951
Jefferson	6,780	3,968	15,475		156	28,482	54,861
Lewis and Clark	55,493	2	3,332		94		58,921
Lincoln	70					65,342	65,412
Madison	5,400	471	3,499			81	9,451
Meagher		157					157
Mineral	10	19,935				38	19,983
Missoula		63	114				177
Park	3,554		76				3,630
Phillips	97,800						97,800
Powell	686	46	286				1,018
Ravalli						156	156
Sanders		365	120				485
Silver Bow	14,882	6,380,426	1	1,873		996,856	7,394,038
	[a] 286,522	6,412,941	31,423	1,873	253	1,090,955	7,823,967
Value per ton in gold and silver	$9.41	$1.75	$25.65	$1.70	$11.72	$4.40	$2.49

[a] Includes 234,663 tons of gold ore, 233 tons of gold and silver ore, and 51,626 tons of silver ore.

GOLD.

The output of gold in Montana decreased from $3,517,253 in 1917 to $3,104,764 in 1918, a decrease of nearly 12 per cent. Since 1915 the decrease has reached $1,899,431. Silver Bow County had the largest total output, $902,094, from deep and placer mines; Lewis and Clark County followed with $634,497, and Deer Lodge County with $453,083. The output of the placers amounted to $396,232, against $467,063 in 1917, a decrease of more than 15 per cent. Most of the placer gold resulted from the operation of dredges in Alder Gulch, Madison County. For several years the production has been diminishing, as the workable ground is being exhausted. A marked decrease was noted in the output of gold of Lewis and Clark, Phillips, and Madison counties, though the gold from Silver Bow County increased considerably. Nearly 30 per cent of the gold, or $930,309, was produced at amalgamation and cyanidation mills, an average recovery of $4.73 a ton of ore and tailings treated. Gold in bullion from deep mines came principally from Lewis and Clark, Fergus, and Phillips counties. The decrease was general on account of the high cost of mining gold. The output from these counties alone was valued at $901,088. In 1917 these three counties produced gold valued at $1,319,201 at gold and silver mills. Nearly 29 per cent of the gold, a quantity valued at $894,480, was contained in concentrates of all kinds, and crude ore shipped to smelters contained $828,330 in gold, or nearly 27 per cent of the total. More than half the gold came from dry or siliceous ores, but there was a large decrease from this source. Gold from copper ore and lead-zinc ore increased considerably.

Nearly 85 per cent of the total gold in 1918 was produced from 14 properties. Four of these produced more than $200,000 each, the Anaconda Co. from copper mines; the Shannon-Piegan-Gloster mines, near Marysville, from siliceous ores; the Southern Cross mine from oxidized iron ores, at Gerogetown; and the Conrey placers in Alder Gulch, Madison County. The other mines were the North Moccasin, the zinc properties of the Anaconda Co., the Ruby Gulch mines, Butte & Superior, Scratch Gravel, Granite Bi-Metallic, Pilgrim, Angelica, Elm Orlu, and North Butte mines.

Mine production of gold in Montana in 1918, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	
Beaverhead	201.72	165.24	83.64	149.30				599.90
Broadwater	211.88	434.73	11.97	58.63				717.21
Cascade		118.17		245.80				363.97
Deer Lodge		21,917.89						21,917.89
Fergus		10,170.40		8.96				10,179.36
Granite	817.68	4,411.46	8.10	2.11				5,239.35
Jefferson	25.64	476.21	511.44	3,306.28		24.57	1,772.78	6,116.92
Lewis and Clark	266.21	29,801.19		618.94		7.45		30,693.79
Lincoln	2.86	52.00					677.00	731.86
Madison	16,261.55	2,365.12	47.01	232.76			109.00	19,015.44
Meagher			.19					.19
Mineral	527.82	5.01	23.05					555.88
Missoula	57.71		11.11	1.23				70.05
Park	28.20	1,045.88		28.14				1,102.22
Phillips		8,358.38						8,358.38
Powell	405.33	156.27	3.01	94.89				659.50
Ravalli	215.41						8.57	223.98
Sanders			7.93	.34				8.27
Silver Bow	145.71	1,135.55	31,757.06		30.82		10,569.66	43,638.80
	19,167.72	a80,613.50	32,464.51	4,747.38	30.82	32.02	13,137.01	150,192.96

a Includes 74,996.31 ounces from gold ore, 121.33 ounces from gold and silver ore, and 5,495.86 ounces from silver ore.

SILVER.

Mines in Montana produced 16,797,479 ounces of silver in 1918, an increase of 3,669,337 ounces, or nearly 28 per cent. The total is greater than the output of any past year and is also greater than the output of any other State in 1918. The value of the output increased $5,799,890, partly on account of the price of the metal, which increased to $1 an ounce. Most of the silver had its source in copper ore and lead-zinc ore; the former produced nearly 63 per cent of the total and the latter 27 per cent. Eighty-nine per cent of the silver came from Silver Bow County, and Jefferson, Granite, and Cascade counties followed in importance of output. Cyanidation and amalgamation mills produced precipitates and bullion containing 115,716 ounces, concentration mills produced concentrates containing 13,471,445 ounces, crude ore shipped to smelters contained 2,771,937 ounces, and 435,215 ounces came from old tailings which were either smelted or leached.

More than 94 per cent of the total silver was produced from 16 properties, each of which had an output of more than 100,000 ounces of silver. Eight of the large mining properties produced more than 400,000 ounces each. These were the copper and zincs mines of the Anaconda Co., and the Butte & Superior, North Butte, Elm Orlu, Davis Daly, Granite Bi-Metallic, and East Butte mines. The other large producers were the tailing dumps at the Butte Reduction works, and at Anaconda, and the Angelica, Butte Copper & Zinc, Tuolumne, Snow Storm, Pilgrim, and Cascade Silver mines.

Mine production of silver in Montana in 1918, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	
Beaverhead	52	20,060	1,709	72,543		84		94,438
Broadwater	28	2,211	451	8,547				11,237
Cascade		25,521		221,002				246,523
Deer Lodge		17,209	6					17,215
Fergus		5,279		446				5,725
Granite	259	465,631	276	4,531				470,697
Jefferson	8	75,854	33,264	314,591		1,748	112,312	537,777
Lewis and Clark	79	80,654	204	53,978		472		135,387
Lincoln		19					156,887	156,906
Madison	2,611	28,221	344	10,870			800	42,846
Meagher			17					17
Mineral	18	1	1,956				427	2,402
Missoula	4		53	8,964				9,021
Park	4	197		1,829				2,030
Phillips		36,983						36,983
Powell	57	940	100	7,048				8,145
Ravalli	18						567	585
Sanders			2,283	3,407				5,690
Silver Bow	28	269,673	10,480,556	1	2,556		4,261,041	15,013,855
	3,166	[a] 1,028,443	10,521,219	707,757	2,556	2,304	4,532,034	16,797,479

[a] Includes 127,127 ounces from gold ore, 2,370 ounces from gold and silver ore, and 898,946 ounces from silver ore.

COPPER.

Montana produced 323,174,850 pounds of copper in 1918, valued at $79,824,188. This total represents an increase in 1918 of 48,712,276 pounds in quantity and $4,895,905 in value. The value of the output was seriously reduced by the fall in the price of the metal, which was 24.7 cents a pound in 1918.

Silver Bow County, which includes the Butte district, contributed all the copper except 2,067,394 pounds. Mines in Broadwater and Mineral counties produced about 500,000 pounds each. Copper ore was the source of nearly all of the copper, though about 2 per cent came from lead-zinc ores. Crude ore of various kinds shipped to smelters in 1918 contained 35,604,629 pounds of copper, an average content of 3.72 per cent. The sulphide copper ore of smelting grade predominated and contained 35,077,521 pounds, an average content of 4.58 per cent, and the oxidized copper ores contained 120,664 pounds, an average of 5.17 per cent. Copper precipitates produced from mine waters and the washings from old tailings contained 4,423,219 pounds. The Washoe works,[1] near Anaconda, treated during 1918 in the copper leaching plant 500,688 tons of tailings and 64,978 tons of copper ore, from which there were produced 6,662 tons of cement copper. Concentrates shipped to smelters, averaging 6.69 per cent of copper, contained 274,210,190 pounds, most of which was from copper concentrates. The output of copper from the Butte or Summit Valley district increased from 270,567,544 pounds in 1917 to 321,103,693 pounds in 1918.

Twelve mines in Montana each produced more than 1,000,000 pounds of copper in 1918. The mines of the Anaconda Copper Mining Co. produced more than the combined product of all others. Other large producers in the order of output were the Butte Reduction Works' dump, tailings at Anaconda, zinc mines of the Anaconda Co., the North Butte, East Butte, Davis Daly, Elm Orlu, Butte Ramsdell, Butte Bullwhacker, Butte & Duluth, and Butte & Superior mines. Outside of the Butte district, the mines which made the best production were the Amador, in Mineral County, and the Furnace Creek Oxide Co., in Broadwater County.

Mine production of copper in Montana in 1918, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaverhead	5,666	75,922	109,175		218		190,981
Broadwater	1,629	571,273	733				573,635
Deer Lodge	163,810	7,522					171,332
Fergus	123		279				402
Granite	30,719	38,616	925				70,260
Jefferson	2,163	182,037	62,752		4,315	94,278	345,545
Lewis and Clark	937	187	348		5,553		7,025
Lincoln						44,658	44,658
Madison	6,432	45,878	1,591			1,003	54,904
Meagher		49,059					49,059
Mineral		500,007					500,007
Missoula		16,199	491				16,690
Powell	123	5,949					6,072
Sanders		34,309	2,515				36,824
Silver Bow	40,162	315,213,962		13,867		5,839,465	321,107,456
	[a] 251,764	316,740,920	178,809	13,867	10,086	5,979,404	323,174,850

LEAD.

The mine production of lead in Montana was 37,135,875 pounds, valued at $2,636,647, in 1918, against 21,951,220 pounds, valued at $1,887,805, in 1917. The total represents the largest production of lead in the history of the State and an increase of more than 69 per cent in quantity. More than 61 per cent of the total lead was derived from mines in Silver Bow County, which produced 22,746,456 pounds, against 10,352,453 pounds in 1917. The production in Lincoln, Jefferson, Cascade, and Beaverhead counties was also considerable, and the largest increases were in Silver Bow, Lincoln, and Jefferson counties. Lead-zinc ore was the source of 82 per cent of the lead, and most of the remainder, or 17.6 per cent, came from lead ore. Crude ore of all kinds shipped to the smelters contained more than 16 per cent of the total lead, or 6,093,940 pounds; concentrates, 30,636,950 pounds, nearly 83 per cent; and old tailings and slags, 404,985 pounds. Lead ore shipped to smelters, most of which was sulphide, contained 5,987,672 pounds of lead, an average of 11.39 per cent; and the lead concentrates contained 9,599,067 pounds, an average of 41.98 per cent. The zinc concentrate contained 5,746,918 pounds, and lead-zinc concentrates 15,275,975 pounds of lead. About 90 per cent of the lead came from 10 properties, seven of which produced more than 1,000,000 pounds each. In the order of output they were the Anaconda Copper, Butte & Superior, Snow Storm, Butte Copper & Zinc, Angelica, Elm Orlu, Pilgrim, Cascade Silver, Davis Daly, and Moulton mines.

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[1] Anaconda Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

[a] Includes 166,947 pounds from gold ore, 1,319 pounds from gold and silver ore, and 83,498 pounds from silver ore.

Mine production of lead in Montana in 1918, in pounds.

County.	Dry or siliceous ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaverhead		1,049,336		775		1,050,111
Broadwater		137,490				137,490
Cascade	24,576	1,075,509				1,100,085
Fergus		5,333				5,333
Granite		22,037				22,037
Jefferson	5,390	2,961,062		14,591	900,439	3,881,482
Lewis and Clark	698	659,413		66,409		726,520
Lincoln					6,820,974	6,820,974
Madison	2,600	425,645			8,960	437,205
Mineral					4,500	4,500
Missoula		16,600				16,600
Park		43,168				43,168
Powell		115,244				115,244
Ravalli					2,874	2,874
Sanders		25,796				25,796
Silver Bow		664	3,214		22,742,578	22,746,456
	[a] 33,264	6,537,297	3,214	81,775	30,480,325	37,135,875

[a] Includes 871 pounds from gold ore, 4,326 pounds from gold and silver ore, and 28,067 pounds from silver ore.

ZINC.

The mine production of recoverable zinc in Montana was 209,258,148 pounds, valued at $19,042,491, in 1918, against 186,259,331 pounds, valued at $18,998,452, in 1917. The difference in quantity represents an increase of more than 12 per cent over the output of 1917, when the mines at Butte suffered from labor troubles; but the increase was not sufficient to bring the total up to that of 1916, when a record output was made. Most of the zinc came from Silver Bow County, but considerable quantities also came from Jefferson, Lincoln, Mineral, Ravalli, and Madison counties. All of the zinc material was sulphide, and nearly all of it was milled. With the exception of 199,198 pounds of zinc from zinc ore, the entire output had its source in lead-zinc ore. During 1918 much of the zinc concentrate from the Butte mines, even from the Butte and Superior and Elm Orlu mines, was shipped to the electrolytic zinc plant at Great Falls when the eastern smelting companies were desirous of curtailing shipments. The zinc plants[1] at Washoe and Great Falls treated during the year 393,193 tons of ore and other zinciferous material, of which 255,057 tons of ore was produced by mines of the company and 138,136 tons of ore and concentrate was purchased from other companies. The plant at Great Falls produced 72,131,238 pounds of electrolytic zinc in 1918, principally from Montana ore, but partly from ore from Idaho and Utah.

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[1] Anaconda Copper Mining Co. Ann Rept. for year ending Dec. 31, 1918.

In 1918 eight mines produced nearly all the zinc. These were the zinc mines of the Anaconda Co., and the Butte & Superior, Elm Orlu, Emma, Pilgrim, Snow Storm, Davis Daly, and Moulton mines. These properties are all at Butte, except the Pilgrim mine, which is in Jefferson County, and the Snow Storm mine, which is in Lincoln County. Concentrates from the Butte & Superior mill at Butte contained 138,841,739 pounds of gross zinc, an average per ton of 51.217 per cent of zinc. The average sales price of zinc of all grades in 1918 was 9.1 cents a pound, a decrease from 10.2 cents in 1917.

Mine production of recoverable zinc in Montana in 1918, in pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Jefferson		2,463,673	2,463,673
Lincoln		1,783,760	1,783,760
Madison		11,114	11,114
Mineral		20,372	20,372
Ravalli		15,451	15,451
Silver Bow	199,198	204,764,580	204,963,778
	199,198	209,058,950	209,258,148

MINING INDUSTRY.

After the depression caused by the strikes in 1917, the mines of Montana returned gradually to a normal output, especially during the early part of the year. A special effort was made to produce metals necessary for munition work—copper, lead, zinc, and manganese—for which there was the unusual war demand. As a result, a larger production of these metals was made and a decided increase was recorded in the production of the accompanying silver, though there was less gold. The mining companies experienced the same difficulties that were met in other States—that is, shortage of labor, increase in wages and freight rates, additional cost for treatment and refining, and lower prices for most of the metals. Consequently the income of the large companies, especially the Anaconda Co., was less than that of 1917. Important improvements were made at the smelting and refining plants at Anaconda and Great Falls. The electrolytic zinc plant made a monthly average in 1918 of more than 6,000,000 pounds of zinc, and the Anaconda copper plants turned out a monthly average of 24,467,000 pounds of copper. A new roller mill for the manufacture of copper rod and wire was completed and operated at Great Falls, and electric furnaces were installed for the manufacture of ferromanganese. Mines at Philipsburg and Butte became important producers of manganese ore, both the carbonate and the oxide. The Emma mine, at Butte, was producing several thousand tons of high-grade manganese carbonate (rhodochrosite) a month, when the signing of the armistice in November reduced the price of war minerals.

METALLURGIC INDUSTRY.

Forty-seven milling plants of various kinds were active in Montana in 1918, though many of them were operated for only a short time. They included 9 plants using the amalgamation process, 4 using amalgamation and concentration, 14 equipped for cyanidation, 4 using table concentration, 10 using oil-flotation equipment after table concentration, and 1 using the flotation method alone. Included also in this total were 3 copper-precipitating plants that extracted copper from mine waters, 1 copper-leaching plant, and 1 electrolytic zinc-leaching plant. Of the 196,611 tons of ore and old tailings treated at gold and silver mills, 6,492 tons were treated by amalgamation and yielded 1,254.43 ounces of gold and 618 ounces of silver, or an average recovery per ton of $3.99 in gold and 0.10 ounce of silver. The ore treated by cyanidation aggregated 168,544 tons, which, with 21,575 tons of old tailings, yielded 43,749.27 ounces of gold and 115,098 ounces of silver, or an average recovery per ton for ore and old tailings of $4.76 in gold and 0.61 ounce of silver. The total value of the bullion recovered from ore and tailings by both amalgamation and cyanidation was $1,046,025, as against an output in 1917 valued at $1,576,793. During 1918, 99 pounds of mercury and 83,542 pounds of sodium cyanide were consumed in gold and silver mills. This represented 0.053 pound of mercury per ounce of gold and silver bullion and 0.015 pound per ton of ore treated. The consumption of cyanide was 0.53 pound per ounce of gold and silver bullion and 0.44 pound per ton of ore and tailings treated. There was a decided decrease in the ore treated and consequently in the bullion recovered by cyanidation.

Gold and silver produced at mills in Montana in 1918.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Beaverhead	8	5.89	7	....	....	$129
Broadwater	24	61.46	14	....	....	1,284
Fergus	[a] 29,168	....	....	[b] 10,086.87	[b] 2,339	210,853
Granite	20	9.92	61	[c] 18.34	[c] 12	657
Jefferson	13	9.34	48	....	....	241
Lewis and Clark	42,435	251.65	96	[d] 24,893.21	[d] 62,753	582,640
Lincoln	70	52.00	19	....	....	1,094
Madison	[e] 1,958	782.80	186	[f] 278.05	[f] 12,909	35,025
Mineral	10	5.00	1	....	....	104
Park	[g] 3,500	66.02	14	....	....	1,379
Phillips	97,800	....	....	8,358.38	36,983	209,766
Powell	13	10.15	2	[h] 114.42	[h] 102	2,679
Silver Bow	17	.20	170	....	....	174
	175,036	1,254.43	618	43,749.27	115,098	1,046,025

[a] Also yielded 1 ton of concentrates.
[b] Includes bullion from 8,200 tons of old tailing.
[c] Includes bullion from 75 tons of old tailing.
[d] Includes bullion from 11,500 tons of old tailing.
[e] Also yielded 22 tons of concentrates.
[f] Bullion from 1,200 tons of old tailing.
[g] Also yielded 369 tons of concentrates.
[h] Bullion from 600 tons of old tailing.

Mills in Montana equipped for the concentration of low-grade ore treated 5,961,753 tons, or about 76 per cent of the total ore mined. The concentrates produced amounted to 2,050,823 tons, containing 43,270.51 ounces of gold, 13,471,445 ounces of silver, 274,210,190 pounds of copper, 30,636,950 pounds of lead, and 209,217,066 pounds of recoverable zinc, valued in all at $103,309,818, or an average value per ton of $50.37. A good increase was made in the quantity and content of the various kinds of concentrates.

Mine production of metals from Montana concentrates in 1918.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Broadwater	5,700	384	....	....	218,836	....	....	$54,052
Fergus	....	1	10.72	112	18	....	....	338
Jefferson	8,684	6,762	1,801.41	116,335	130,168	915,030	2,463,673	474,886
Lewis and Clark	10	5	8.97	74	536	1,097	....	469
Lincoln	65,342	8,738	677.00	156,887	44,658	6,820,974	1,783,760	828,524
Madison	4,830	489	921.55	6,305	6,319	153,773	11,114	38,846
Mineral	19,840	1,834	18.00	1,942	490,720	....	....	123,522
Park	....	369	913.48	145	....	....	....	19,028
Ravalli	....	26	8.57	567	....	2,874	15,451	2,354
Silver Bow	5,857,347	2,032,215	38,910.81	13,189,078	273,318,935	22,743,202	204,943,068	101,767,799
	5,961,753	2,050,823	43,270.51	13,471,445	274,210,190	30,636,950	209,217,066	103,309,818

By kinds of concentrates.

	Quantity.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value of concentrates.
Dry or siliceous	1,669	1,738.36	20,142	33,389	....	....	$64,324
Copper	1,738,462	28,327.32	8,928,624	268,207,471	....	....	75,761,446
Lead	11,432	1,838.06	264,612	60,337	9,599,067	....	999,045
Zinc	190,254	5,927.73	2,685,344	2,181,356	5,746,918	164,133,383	18,690,845
Copper-lead	54	24.56	1,786	4,764	14,990	....	4,535
Lead-zinc	108,952	5,414.48	1,570,937	3,722,873	15,275,975	45,083,683	7,789,623

Crude ore directly smelted, 478,860 tons, contained 40,070.44 ounces of gold, 2,771,937 ounces of silver, 35,604,629 pounds of copper, 6,093,940 pounds of lead, and 41,082 pounds of zinc, valued in all at $12,831,018, or an average of $26.79 a ton. The following table shows that there was a decrease in the quantity and value of the first-class ore. In 1917 the total was 503,023 tons, valued at $15,646,263.

Mine production of metals from Montana crude ore shipped to smelters in 1918.

By counties.

County.	Quantity.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaverhead	2,436	387.32	89,396	166,214	645,126	....	$184,262
Broadwater	1,650	443.87	11,195	354,799	137,490	....	117,768
Cascade	4,615	363.97	246,523	....	1,100,085	....	332,153
Deer Lodge	36,885	21,917.89	17,215	171,332	....	....	512,617
Fergus	102	81.77	3,274	384	5,333	....	5,439
Granite	13,427	2,256.11	316,731	70,260	22,037	....	382,287
Jefferson	18,751	4,049.61	358,471	215,377	2,966,452	....	706,000
Lewis and Clark	4,976	5,273.75	72,385	6,489	725,423	....	234,511
Madison	1,463	771.49	20,835	48,585	283,432	....	68,909
Meagher	157	.19	17	49,059	....	....	12,139
Mineral	133	5.06	441	9,287	4,500	20,372	5,012
Missoula	177	12.34	9,017	16,690	16,600	....	14,573
Park	130	94.52	1,867	....	43,168	....	6,886
Powell	405	129.60	7,984	6,072	115,244	....	20,345
Sanders	485	8.27	5,690	36,824	25,796	....	16,786
Silver Bow	393,068	4,274.68	1,610,896	34,453,257	3,254	20,710	10,211,331
	478,860	40,070.44	2,771,937	35,604,629	6,093,940	41,082	12,831,018

By kinds of ore.

	Quantity.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
Dry or siliceous	68,372	31,528.15	691,846	245,980	32,393	....	$1,406,648
Copper	384,007	3,829.80	1,378,912	35,198,185	....	....	10,152,033
Lead	26,284	4,700.54	699,824	154,042	5,987,672	....	1,260,166
Zinc	72	4.50	410	1,100	2,590	20,710	2,843
Copper-lead	87	7.45	518	5,322	66,785	....	6,728
Lead-zinc	38	....	427	....	4,500	20,372	2,600

PRODUCTION BY COUNTIES.

GENERAL FEATURES.

The following tables give the production of each metal, by counties with its total value in 1918, the production of ore and its average value per ton by counties in 1917 and 1918, and the statistics of placer mines in 1917 and 1918. They are followed by a review of the mining industry for each county and each producing mining district.

Mine production of gold, silver, copper, lead, and zinc in Montana in 1918.

County.	Gold.					Silver.	
	Placers.		Deep Mines.		Total value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.			
	Fine ounces.		*Fine ounces.*			*Fine ounces.*	
Beaverhead	201.72	$4,170	398.18	$8,231	$12,401	94,438	$94,438
Broadwater	211.88	4,380	505.33	10,446	14,826	11,237	11,237
Cascade	....	....	363.97	7,524	7,524	246,523	246,523
Deer Lodge	....	....	21,917.89	453,083	453,083	17,215	17,215
Fergus	....	....	10,179.36	210,426	210,426	5,725	5,725
Granite	817.68	16,903	4,421.67	91,404	108,307	470,697	470,697
Jefferson	25.64	530	6,091.28	125,918	126,448	537,777	537,777
Lewis and Clark	266.21	5,503	30,427.58	628,994	634,497	135,387	135,387
Lincoln	2.86	59	729.00	15,070	15,129	156,906	156,906
Madison	16,261.55	336,156	2,753.89	56,928	393,084	42,846	42,846
Meagher	....	....	.19	4	4	17	17
Mineral	527.82	10,911	28.06	580	11,491	2,402	2,402
Missoula	57.71	1,193	12.34	255	1,448	9,021	9,021
Park	28.20	583	1,074.02	22,202	22,785	2,030	2,030
Phillips	....	....	8,358.38	172,783	172,783	36,983	36,983
Powell	405.33	8,379	254.17	5,254	13,633	8,145	8,145
Ravalli	215.41	4,453	8.57	177	4,630	585	585
Sanders	....	....	8.27	171	171	5,690	5,690
Silver Bow	145.71	3,012	43,493.09	899,082	902,094	15,013,855	15,013,855
	19,167.72	396,232	131,025.24	2,708,532	3,104,764	16,797,479	16,797,479

County.	Copper.		Lead.		Recoverable zinc.		Total value.
	Quantity	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Beaverhead	190,981	$47,172	1,050,111	$74,558	....	....	$228,569
Broadwater	573,635	141,688	137,490	9,762	....	....	177,513
Cascade	....	....	1,100,085	78,106	....	....	332,153
Deer Lodge	171,332	42,319	....	....	....	....	512,617
Fergus	402	99	5,333	379	....	....	216,629
Granite	70,260	17,354	22,037	1,565	....	....	597,923
Jefferson	345;545	85,350	3,881,482	275,585	2,463,673	224,194	1,249,354
Lewis and Clark	7,025	1,735	726,520	51,583	....	....	823,202
Lincoln	44,658	11,031	6,820,974	484,289	1,783,760	162,322	829,677
Madison	54,904	13,561	437,205	31,042	11,114	1,011	481,544
Meagher	49,059	12,118	....	....	....	....	12,139
Mineral	500,007	123,502	4,500	319	20,372	1,854	139,568
Missoula	16,690	4,122	16,600	1,179	....	....	15,770
Park	....	....	43,168	3,065	....	....	27,880
Phillips	....	....	....	....	....	....	209,766
Powell	6,072	1,500	115,244	8,182	....	....	31,460
Ravalli	....	....	2,874	204	15,451	1,406	6,825
Sanders	36,824	9,095	25,796	1,831	....	....	16,787
Silver Bow	321,107,456	79,313,542	22,746,456	1,614,998	204,963,778	18,651,704	115,496,193
	323,174,850	79,824,188	37,135,875	2,636,647	209,258,148	19,042,491	121,405,569

Ore sold or treated, mines producing, and average value per ton of ores in Montana in 1917 and 1918.

County.	Ore sold or treated, 1918 (short tons).		Number of deep mines producing.		Average value per ton.[a]		Average value per ton in gold and silver.[a]	
	Quantity.	Increase or decrease.	1917	1918	1917	1918	1917	1918
Beaverhead	4,583	− 7,147	35	30	$30.30	$48.95	$12.84	$22.39
Broadwater	7,374	− 3,770	37	29	31.66	23.48	6.17	2.94
Cascade	4,615	− 2,176	34	22	41.88	71.97	25.45	55.05
Deer Lodge	36,885	− 15,295	14	5	10.05	13.90	9.08	12.75
Fergus	37,470	− 674	9	11	7.12	5.78	7.11	5.77
Gallatin	....	− 18	2	....	55.11	....	.11	....
Granite	26,951	+ 5,830	33	37	28.52	21.55	22.86	20.85
Jefferson	54,861	− 12,771	75	55	19.08	22.76	5.56	12.10
Lewis and Clark	58,921	− 18,738	77	42	14.28	13.88	12.81	12.97
Lincoln	65,412	+ 3,135	2	2	9.49	12.68	1.53	2.63
Madison	9,451	− 5,069	97	62	11.97	15.11	7.98	10.28
Meagher	157	− 716	7	5	28.56	77.32	.61	.13
Mineral	19,983	− 2,582	6	4	7.75	6.44	.36	.15
Missoula	177	− 511	8	3	29.23	82.33	10.06	52.38
Park	3,630	+ 3,465	6	4	40.87	7.52	19.03	6.67
Phillips	97,800	− 125,550	2	2	1.94	2.14	1.94	2.14
Powell	1,018	− 1,127	14	18	10.78	22.62	6.24	13.11
Ravalli	156	− 11,944	1	1	5.74	15.09	1.26	4.77
Sanders	485	− 519	8	6	43.00	34.61	9.75	12.08
Silver Bow	7,394,038	+1,712,980	51	69	18.19	15.62	1.79	2.15
	7,823,967	+1,516,803	518	407	17.39	15.47	2.20	2.49

[a] Value per ton, placer product excluded.

Number and production of producing placer mines in Montana in 1917 and 1918.

County.	1917						1918					
	Hydraulic, dry, and sluicing.	Dredging.	Drift.	Gold.	Silver. *Fine ounces.*	Total value.	Hydraulic, dry, and sluicing.	Dredging.	Drift.	Gold.	Silver. *Fine ounces.*	Total value.
Beaverhead	2	......	......	$575	2	$577	6	......	......	$4,170	52	$4,222
Broadwater	6	......	......	4,931	41	4,965	5	......	......	4,380	28	4,408
Granite	6	......	......	13,123	176	13,268	6	......	......	16,903	259	17,162
Jefferson	9	......	......	743	12	753	2	......	......	530	8	538
Lewis and Clark	15	......	2	6,213	56	6,259	14	......	1	5,503	79	5,582
Lincoln	1	......	......	23	......	23	1	......	......	59	......	59
Madison	5	1	......	413,570	3,136	416,154	7	1	......	336,156	2,611	338,767
Meagher	2	......	......	619	4	622	......	......	......	......	......	......
Mineral	16	......	......	7,031	10	7,039	11	......	2	10,911	18	10,929
Missoula	5	......	......	1,242	3	1,245	5	......	......	1,193	4	1,197
Park	3	......	......	257	1	258	1	......	1	583	4	587
Powell	16	......	1	14,194	84	14,263	14	......	1	8,379	57	8,436
Ravalli	3	......	......	831	4	834	2	......	......	4,453	18	4,471
Sanders	1	......	......	53	......	53	......	......	......	......	......	......
Silver Bow	5	......	......	3,658	22	3,676	5	......	1	3,012	28	3,040
	95	1	3	467,063	3,551	469,989	79	1	6	396,232	3,166	399,398

BEAVERHEAD COUNTY.

Thirty deep-mine operators produced 4,583 tons of ore, a decrease of 7,147 tons. The total average value per ton increased from $30.30 in 1917 to $48.95 in 1918, and the gold and silver value increased from $12.84 to $22.39 a ton. More than half of the ore mined in 1918 was of shipping grade and contained $8,007 in gold, 89,396 ounces of silver, 166,214 pounds of copper, and 645,126 pounds of lead, valued in all at $184,262, or an average of $75.64 a ton. The largest part of the county output, or 3,763 tons, was lead ore and old lead slag; 415 tons was copper ore, and 402 tons was dry or siliceous ore. Placer bullion contained $4,170 in gold and 52 ounces of silver against a yield of $575 in gold and 2 ounces of silver in 1917.

Argenta district.—Seven deep mines produced 1,127 tons of ore, containing $2,486 in gold, 6,139 ounces of silver, 13,993 pounds of copper, and 275,208 pounds of lead, valued in all at $31,621, or an average value per ton of $28.06. There was 469 tons of first-class ore shipped, and the remainder was old slag. Shipments of sulphide lead ore came from the Tilden group, the most important producer.

Bannack district.—Four deep mines and 3 placers produced 88 tons of ore, $7,185 in gold, 356 ounces of silver, and 4,622 pounds of copper, valued in all at $8,683. The placer product contained $3,572 in gold and 50 ounces of silver, and the ore had an average value per ton of $57.51. Several shipments of rich gold ore were made from the property of the Bannack Gold Mining Co., which produced considerable bullion in 1917.

Beaverhead district.—Three deep mines and 2 placers produced 174 tons of ore, $1,462 in gold, 2,501 ounces of silver, and 44,470 pounds of lead, valued in all at $14,947. The placer product was valued at $510, and the ore, all of which was a first-class product, had an average value per ton of $82.97. The largest output came from the Dark Horse property, which produced a sulphide copper ore. For a short time sluicing operations were carried on at the I. X. L. placer.

Blue Wing district.—The output of the district was small and consisted of a few tons of lead ore from the Colonel Ingersoll mine and shipments of siliceous silver ore from the Kent and Huron properties.

Bryant district.—Eight deep mines produced 2,835 tons of ore, containing $745 in gold, 66,859 ounces of silver, 118,118 pounds of copper, and 765,383 pounds of lead, valued in all at $151,121, or an average value per ton of $53.31. Approximately half of the product was first-calss shipping ore and the remainder was a lead slag. Most of the ore, as well as the old slag, was shipped from the Hecla group, located at Hecla. The Clipper mine, operated by the Anaconda Copper Mining Co., produced several shipments of sulphide copper ore.

Elkhorn district.—Though no shipments were made from this district, much development work was done by the Boston & Montana Development Co., which controls 1,500 acres of mineral land about 40 miles southwest of Divide and 50 miles northwest of Dillon. Shipments await the completion of a narrow-gage railroad from Divide, on the Oregon Short Line Railroad, to the mines, 38 miles southwest on Wise River. Extracts from the report[1] follow:

> Had we been in position to secure all necessary financial assistance, the labor problem would have prevented the completion of the railroad and the maturity of our plans. Labor was almost impossible to secure and of such poor quality that in addition to the increase in the wage scale, the inefficiency was such as to add greatly to the cost. * * *
>
> An average of about 35 men were employed at the mines during the year. The work done consisted of drifting and crosscutting on the Park, Elkhorn, and Idanha veins at the 1,000-foot level and in raising at two places from the 1,000-foot

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[1] Boston & Montana Development Co. Ann. Rept. for year ending Dec. 31, 1918.

> level on the Idanha vein toward the upper workings, in all a distance of 1,364 feet during the year. The year's work has demonstrated our previous opinion and reports concerning the width and value of the veins, and the upraises in the Idanha vein have opened up a larger volume of high-grade ore than we anticipated. This ore can be shipped direct to the smelters as soon as the railroad is completed. * * *
>
> Recent samplings across a face of 7 feet of the high-grade ore in the Idanha upraise showed the following values, which are not given as being a general average of the entire vein, but to show the proportion of the various minerals: Gold, 0.45 ounce; silver, 12 ounces; copper, 6 per cent; and lead, 20 per cent. * * *
>
> The railroad will be completed in June. With the exception of a few points, the grading is all done and the ties nearly all delivered. The rail is being shipped from three points, and the rail-laying crew is at work. * * *
>
> Work on the 500-ton concentrating-flotation plant has been delayed awaiting railroad completion; however, during the past year our consulting engineer has completed all necessary tests with ore, and drawn the plans and specifications for the mill and determined the kind and character of machinery needed.

The printed report was supplemented by a pamphlet giving interesting views of the progress of the work, as well as a cross-section drawing of the Idanha vein.

Polaris district.—The Polaris mine was operated continuously throughout the year by the Silver Fissure Mining Co. Several shipments of siliceous silver ore were made and a 50-ton plant was installed during the year, designed to use a chloridizing-roasting and leaching process.

Utopia district.—The Indian Queen mine at Apex produced several shipments of copper ore.

Vipond district.—Aside from small test shipments, the product of the district was a siliceous silver ore from the Gray Jockey property.

BROADWATER COUNTY.

Twenty-nine operators of deep mines produced 7,374 tons of ore in 1918, a decrease of 3,770 tons. The total average value per ton decreased from $31.66 in 1917 to $23.48 in 1918, and the gold and silver value in this ore from $6.17 to $2.94. The greater part of the ore, or 5,700 tons, was milled and reduced to 384 tons of copper concentrates. The remainder, excepting a small quantity treated by amalgamation, was first-class ore. The total output consisted of 6,627 tons of copper ore, 354 tons of siliceous ore, and 393 tons of lead ore. The concentrates had an average value per ton of $140.76. and the first-class ore $71.37. The placer bullion contained $4,380 in gold and 28 ounces of silver, against $4,931 in gold and 41 ounces of silver in 1917.

Backer district.—A few tons of rich gold quartz were milled at the Slim Jim property, near Canton, and some gold bullion was shipped from the Confederate placer.

Beaver district.—Seven deep mines and 1 placer produced 74 tons of ore, $3,023 in gold, 1,459 ounces of silver, and 10,198 pounds of lead, valued in all at $5,206. The ore had an average value per ton of $41.07. Small shipments were made from the Hyantha, Chance, Little Bonanza, Little Olga, Lone Star, and New Year mines. A fair production of placer gold came from the Indian Creek property which was operated about seven months.

Cedar Plains district.—Fourteen deep mines and 2 placers produced 731 tons of ore, $8,771 in gold, 7,395 ounces of silver, 17,645 pounds of copper, and 68,930 pounds of lead, valued in all at $25,418. Practically all the ore was a first-class shipping product and had an average value per ton of $34.01. In 1917 the mines of the district produced 4,251 tons of ore, valued at $72,731. Good shipments were made from the Summit, Black Friday, Alaska, Keating, North Home, and Ruby Silver mines. A few ounces of gold came from the Radersburg and Cow Creek placers.

Hellgate district.—The Argo mine, operated by the Furnace Creek Oxide Copper Co., was active throughout the year. Crude ore and concentrates from the 50-ton mill were shipped. Electric power is received from Canyon Ferry, about 8 miles distant. The following paragraphs are taken from the printed report.[1]

> In August, the mine having been opened to a depth of 150 feet below the tunnel, we made a final settlement and took title to the property * * * at a total cost of $150,214.80, instead of $225,000, the price in the original option. * * *
>
> Since that time we have sunk the shaft 60 feet deeper, and in the new level, which we call the 200, we have developed a new ore body, which is sufficiently encouraging to justify sinking another 100 feet as soon as possible. * * *
>
> The ore extracted by us from January, 1917, to October 1, 1918, amounted to 10,707 tons, and the development and exploration work aggregated 2,977 feet, or 3.6 tons per linear foot. * * *
>
> Figuring cost per pound of copper produced, we have the following figures: Average price at which copper was sold, 25.838 cents; smelter charges and deductions, 6.30 cents; hauling and freight, 2.085 cents; mining, concentrating, and general expenses, 10.142 cents; new equipment, 0.47 cent; total expenses, 18.997 cents; profit per pound of copper, 6.841 cents. * * *
>
> The mill equipment is not up to date—that is, it contains no machinery for fine crushing and for flotation.
>
> There was a considerable pile of tailings when we began operations, say 4,000 tons, and we have added about 8,000 tons. * * *
>
> The production from January, 1917, to December 31, 1918, was 2,492 tons of crude ore and concentrate, containing 1,273,603 pounds of copper.

Park district.—The output from 6 deep mines and one placer consisted of 138 tons of ore, $749 in gold, 2,360 ounces of silver, and 58,362 pounds of lead, valued in all at $7,253. The ore had an average value per ton of $50.32, and came principally from the Iron Mask, Jay Gould, and Rabdau properties. The Iron Mask mine was operated by the Bamar Copper Co. and produced several shipments of lead ore.

CASCADE COUNTY.

Mine production in Cascade County, Mont., in 1917 and 1918.

Year.	Number of producers.	Ore	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	34	6,791	4,555	204,178	1,023	1,295,063	$284,452
1918	22	4,615	7,524	246,523	....	1,100,085	332,153
Increase or decrease, 1918	....	−2,176	+2,969	+42,345	−1,023	−194,978	+47,701

Twenty-two deep mines in 1918 produced 4,615 tons of ore, a decrease of 2,176 tons. The total average value per ton of the ore increased from $41.88 in 1917 to $71.97 in 1918, and the gold and silver value per ton from $25.45 to $55.05. The total output of the county amounted to $332,153. All the ore was shipped directly to smelting plants, and most of it was lead ore.

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[1] Furnace Creek Oxide Copper Co. Report of operations from January, 1917, to October 1, 1918.

At Black Eagle, near Great Falls, the Anaconda Copper Mining Co. owns the smelting plant formerly operated by the Boston & Montana Co. There are roasters, four blast furnaces, two reverberatories, and two converters. As most of the smelting of the ores from Butte is now done at Anaconda, only part of this equipment was active in 1918. Zinc concentrates were roasted and residues from the zinc plant were treated in a reverberatory furnace. A mile from the site of the smelter are the electrolytic copper plant capable of refining 190,000,000 pounds of copper per annum, the zinc leaching plant and electrolytic refinery, which has a capacity of 6,000,000 pounds of zinc per month, and the plant for the manufacturing of copper rod and wire. Zinc ore from the mines at Butte is concentrated, together with custom material, at Anaconda, concentrates are roasted at Anaconda and Great Falls, and the resultant calcine leached with sulphuric acid in Pachuca tanks. From time to time changes have been made in the method of leaching the zinc material to purify the solution and to assure a high saving of the gold, silver, copper, and lead in the residues. For a time there was great difficulty with silica, since part of it was soluble. The process [1] of dehydrating silica making it insoluble was published in December.

Montana district.—Twenty deep mines produced 4,533 tons of ore, containing $7,520 in gold, 240,653 ounces of silver, and 1,088,993 pounds of lead, valued in all at $325,491, or an average value per ton of $71.80. There was a decrease in the shipments of ore, but the grade of ore was better. All the ore was shipped without treatment, and most of it was sulphide lead ore. The ore contains considerable silver, and some of it is sufficiently high in silver and low in lead to be classed as a silver ore. The largest output of the district came from the Moulton and Broadwater mines, operated by the Cascade Silver Mines & Mills. The property is equipped with a concentration plant, which was not operated during 1918 though new machinery was purchased. Other shipments came from the Wright & Edwards, Florence, Galt, Tom Hendricks, Liberty, Queen, and Silver Belt mines.

Running Wolf Creek district.—Two deep mines produced ore valued at $6,662. Shipments of lead ore came from the Mountainside and Romer mines. The output of the district in 1917 was 303 tons of ore, valued at $13,321.

DEER LODGE COUNTY.

Mine production in Deer Lodge County, Mont., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	
1917	14	52,180	$456,588	20,817	186,680	$524,705
1918	5	36,885	453,083	17,215	171,332	512,617
Decrease, 1918		15,295	3,505	3,602	15,348	12,088

Five deep-mine operators reported the production of 36,885 tons of ore in 1918, a decrease of 15,295 tons. The total value per ton increased from $10.05 in 1917 to $13.90 in 1918, and the gold and silver value per ton from $9.08 to $12.75. The ore contained much gold and some silver and copper, and was shipped to the Washoe smelter, where it was used as a flux. No placer production was reported in 1918.

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[1] Eng. and Min. Jour., Dec. 28, 1918, p. 1117.

The most important smelting operations of the State are carried on in this county. The Washoe plant of the Anaconda Copper Mining Co. is situated near Anaconda, 24 miles northwest of Butte. Ore from the mines at Butte is hauled by electric trains over the Butte, Anaconda & Pacific Railway. The plant consists of a concentration mill, copper-leaching plant, copper smelter, and an elaborate plant for the treatment of fume and dust. The mill, equipped for table concentration and oil flotation, has a capacity of 16,000 tons a day and treats both copper ore and lead-zinc ore. The smelter has three unusually large blast furnaces, nine reverberatory furnaces, and seven converters of the Great Falls type, giving a greater capacity than any other copper plant in North America. The copper-leaching plant has a capacity of 2,000 tons a day and treats old mill tailings as well as oxidized ore from Butte. The plants are described in the various annual reports of the Anaconda Copper Mining Co. and in the Mines Handbook.[1]

In March a special article [2] on the leaching plant was published in the Mining and Scientific Press, and earlier in the year a pamphlet on the entire plant was issued by the Anaconda Copper Mining Co., which gave interesting views and a simple description of the various features. During 1918 a new stack 585 feet high was completed and progress was made on the fume-treatment plant.[3]

Georgetown district.—Four deep mines produced 36,824 tons of ore, $453,083 in gold, 17,209 ounces of silver, and 163,810 pounds of copper, valued in all at $510,753, an average value per ton of $13.87. In 1917 mines in this district produced 52,085 tons of ore, valued at $521,849. Most of the output, as in former years, was an oxidized iron ore containing gold, silver, and copper from the Southern Cross property. Shipments of ore similar in character were made from the Pyrenees mine, operated by the Clark Montana Realty Co. Several hundred tons of ore containing considerable gold were shipped from the Holdfast mine, and siliceous silver ore was shipped from the Snowstorm property.

Oro Fino district.—Several shipments of oxidized copper ore were made from the Independence property, which is opened by a 100-foot shaft.

FERGUS COUNTY.

Mine production in Fergus County, Mont., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	9	38,144	$268,835	2,979	245	4,595	$271,752
1918	11	37,470	210,426	5,725	402	5,333	216,629
Increase or decrease, 1918	....	−674	−58,409	+2,746	+157	+738	−55,123

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[1] Weed, W. H., Mines Handbook, vol. 13, 1918.

[2] Laist, F., and Maguire, H. J., The 2,000-ton leaching plant at Anaconda: Min. and Sci. Press, Mar. 16, 1918, p. 365.

[3] Brown, D. M., New fume-treatment plant at Anaconda: Min. and Sci. Press, June 29, 1918, p. 895.

Eleven operators of deep mines reported the production of 37,470 tons of ore, a decrease of 674 tons. All the ore, with the exception of 17 tons, was siliceous, and most of it, with some old tailings, was treated by cyanidation. The ore and tailings milled had an average value per ton of $5.64, and the ore shipped (102 tons) was valued at $53.32 a ton. Several of the mines producing low-grade gold ore suffered from increased expenses and difficulties of transportation.

North Moccasin district.—Three deep mines produced 28,549 tons of ore, containing $193,720 in gold and 2,324 ounces of silver, valued in all at $196,044, or an average value per ton of $6.87. The entire production of the district, with the exception of one shipment of first-class ore, was treated in cyanidation plants. Shipments of bullion were made from the North Moccasin and Kendall mines, operated by the Barnes King Development Co. The printed report [1] gives the following notes:

> The North Moccasin mine production for the year 1918 was 5,412 tons less than for the preceding year, closely following the falling off in the available labor supply.

Comparison of production by years.

Year.	Quantity (short tons).	Value per ton.	Bullion sales.
1913	49,726	$8.89	$400,854.43
1914	51,471	8.44	424,410.96
1915	47,038	9.80	418,568.76
1916	33,715	8.65	253,788.29
1917	26,790	8.53	227,925.13
1918	21,378	8.19	178,229.98

> One stope of importance was opened between the 300 and 200 levels, immediately back of the Santiago shaft. So far no extension of this ore body has been found on the 200 or 100 levels. Exploration on the lowest level has been very unsatisfactory, and no important tonnage has been developed there.
>
> Ore reserves on January 1 were estimated at 5,235 tons, of $8.90 per ton grade, consisting of pillars mainly. * * *
>
> The Kendall mine and mill were under lease and no attempt was made to work below the 100 level. In order to reach the lowest point in the old open cut and have the track to the mill free from slides, a foot wall drift 500 feet in length was driven by the leasers. * * *
>
> The total production was 7,152 tons of ore, averaging $1.80 per ton, on which the sum of $656.83 was paid as royalty.

Warm Springs district.—Eight deep mines produced 8,921 tons of ore, containing $16,706 in gold, 3,401 ounces of silver, 402 pounds of copper, and 5,333 pounds of lead, valued in all at $20,585, or an average value per ton of $2.31. Most of the tonnage was old tailings treated by cyanidation at the Gold Reef property. Several hundred tons of ore of better grade was treated at the Cumberland and Maginnis properties. The Spotted Horse mine, formerly an important producer, was idle. A shipment of siliceous silver ore was made from the Silver Bullion mine near Maiden.

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[1] Barnes King Development Co. Ann. Rept. for year ending Dec. 31, 1918.

GRANITE COUNTY.

Mine production in Granite County, Mont., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	39	21,121	$128,845	445,806	419,983	57,087	$615,753
1918	43	26,951	108,307	470,697	70,260	22,037	597,923
Increase or decrease, 1918	....	+5,830	−20,538	+24,891	−349,723	−35,050	−17,830

[a] Includes placer production.

Thirty-seven deep-mine producers mined 26,951 tons of ore in 1918, or 5,830 tons more than was mined by 33 producers in 1917. The total average value per ton decreased from $28.52 in 1917 to $21.55 in 1918, and the gold and silver value per ton from $22.86 to $20.85. The crude ore shipped, 13,427 tons, contained gold, silver, copper, and lead, and had an average value per ton of $28.47. The remainder, except 20 tons treated in gold and silver mills, consisted of old tailings, which were smelted. Six placer operators reported the yield of $16,903 in gold and 259 ounces of silver, against $13,123 in gold and 176 ounces of silver from 6 placers in 1917. The mines of the county also produced a large output of manganese ore, which was shipped to steel plants in the Eastern States.

Alps district.—A few tons of ore from the Rainy Day mine, near Bonita, was treated by amalgamation.

Dunkleberg district.—Several shipments of oxidized lead ore were made from the Forest Rose mine, operated by Dunkleberg Mining Co. The deposits were described in a Survey bulletin.[1]

First Chance or Garnet district.—Six deep mines and two placers produced 636 tons of ore, $20,972 in gold, 1,870 ounces of silver, and 19,056 pounds of copper, valued in all at $27,549. The ore, all of which was a shipping product, had an average value per ton of $42.91. Most of the ore came from the Nancy Hanks property, though the total was less than that of 1917. Ore from this property contained an average of more than 2 ounces of gold per ton, as well as some silver and copper. Other shipments were made from the Butte & Garnet, First Chance, Mountain, and Red Rock properties. The ore deposits of this district and other districts in the vicinity have been fully described in a recent bulletin.[2]

Flint Creek district.—Nineteen deep mines and one placer produced 25,800 tons of ore, $70,142 in gold, 456,732 ounces of silver, 18,466 pounds of copper, and 10,874 pounds of lead, valued in all at $532,207. The ore had an average value per ton of $20.62. Nearly all of the output of the district was a siliceous silver ore and old tailings from the Granite-Bimetallic property at Philipsburg. Several hundred tons of siliceous silver ore were also shipped by the Philipsburg Mining Co. and the Beaver Creek Mining Co. Smaller shipments were made from the Black Pine, Comanche Extension, Harrison,

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[1] Pardee, J. T., The Dunkleberg mining district, Granite County, Mont.: U. S. Geol. Survey Bull. 660, pp. 241-247, 1918.

[2] Pardee, J. T., Ore deposits of the northwestern part of the Garnet Range, Mont.: U. S. Geol. Survey Bull. 660, pp. 159-239, 1918.

Homer, Juniper, McKay, Moonlight, Hobo, and Trout properties. Aside from these shipments, the district was one of the most important producers of manganese in the West.

Henderson district.—A small tonnage of old tailings was treated in the 10-ton plant on the Windfall property.

Rock Creek district.—An important production of placer gold was made at the basin mine, 20 miles west of Philipsburg. The property was operated only 98 days.

South Boulder district.—Nine deep mines and 1 placer produced 427 tons of ore, $763 in gold, 11,844 ounces of silver, 32,738 pounds of copper, and 11,163 pounds of lead, valued in all at $21,486. All of the ore was a shipping product and had an average value per ton of $49.07. The largest production was made from the Royal Basin mine, near Maxville, and consisted of sulphide copper ore. The mine was inactive during the greater part of the year, and the 300-ton mill equipped with flotation cells was idle. Shipments were also made from the Durand, Eagle, Fair Play, Mount Powell, Nonpareil, Brooklyn, and Queen properties.

JEFFERSON COUNTY.

Mine production in Jefferson County, Mont., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	84	67,632	$109,406	324,686	1,215,385	2,455,350	3,638,085	$1,290,992
1918	57	54,861	126,448	537,777	345,545	3,881,482	2,463,673	1,249,354
Increase or decrease, 1918	......	−12,771	+17,042	+213,091	−869,840	+1,426,132	−1,174,412	−41,638

[a] Includes placer production.

Fifty-five deep-mine producers in 1918 reported from Jefferson County 54,861 tons of ore, a decrease of 12,771 tons. The total average value per ton of ore increased from $19.08 in 1917 to $22.76 in 1918 and the gold and silver value per ton from $5.56 to $12.10. The output consisted of 18,751 tons of first-class ore, 5,891 tons of tailings shipped, and 8,684 tons of ore and 21,522 tons of tailings concentrated. Concentrates (6,762 tons) had a total value of $474,886, or a value of $70.23 a ton. The shipping ore contained gold, silver, copper, and lead valued at $706,000, or an average value per ton of $37.65. The ore and tailings were classified as 28,482 tons of lead-zinc material, 15,475 tons of lead ore, 6,780 tons of siliceous ore and tailings, 3,968 tons of copper ore, and 156 tons of copper-lead ore. The production of 2 placer operators amounted to $530 in gold and 8 ounces of silver. The mines of this county are north and east of Butte, are close to the smelters at East Helena, Butte, and Anaconda, and are served by three railroads.

Amazon district.—Three deep mines near Amazon produced 133 tons of ore, containing $542 in gold, 1,887 ounces of silver, 60 pounds of copper, and 6,414 pounds of lead, valued in all at $2,900, or an average value per ton of $21.80. The output of the district was a mixture of sulphide lead ore and siliceous silver ore and came principally from the Australian mine.

Boulder district.—Three deep mines produced 258 tons of ore, containing $655 in gold, 3,776 ounces of silver, 4,946 pounds of copper, and 32,461 pounds of lead, valued in all at $7,957, or an average value per ton of $30.85. The concentration mill on the Bland & Weaver property was idle, but a shipment of copper-lead concentrates was made from operations in 1917. The Baltimore property was operated in December and several test shipments were made before the end of the year. The shipping point is Boulder, on the Great Northern Railway. In 1917 the output of the district was 2,266 tons of ore, which had a total value of $69,683.

Cataract district.—The output of 15 deep mines and 1 placer in the vicinity of Basin was 33,210 tons of ore and old tailings, containing $63,369 in gold, 204,882 ounces of silver, 181,667 pounds of copper, 1,496,920 pounds of lead, and 2,463,673 pounds of recoverable zinc, valued in all at $643,598. The output had an average value per ton of $19.37. The tonnage included 6,960 tons of ore and 21,522 tons of old tailings milled, as well as 4,728 tons of first-class shipping ore. The Erin placer on Overland Creek, 12 miles from Basin, produced a small quantity of gold. Most of the output of the district came from the Comet and Silver Hill mines, operated by the Pilgrim Mining Co. Lead-zinc ore and old tailings were treated in a 100-ton concentration plant. The lead product was shipped to East Helena and the zinc concentrates to the electrolytic plant at Great Falls. Similar material came from the Crystal mine at Basin. The Bullion Mining Co. shipped both copper ore and lead ore. Several hundred tons of sulphide lead ore were shipped from the West Rumley mine, and smaller shipments were made from the Helper, Hope, I Don't Know, Zinc B., Montana, Canadian, Evening Star, and Virginia mines. The Hope mine and several adjoining claims have since been operated by the Jib Mining Co. Early in 1919 some ore unusually rich in gold and silver was shipped to Anaconda.

Colorado district.—Eleven deep mines near Corbin or Wickes, produced 14,145 tons of ore, containing $44,432 in gold, 239,357 ounces of silver, 124,125 pounds of copper, and 2,253,681 pounds of lead, valued in all at $474,459, or an average vlaue per ton of $33.54. Most of the ore, 12,577 tons, was first-class shipping product, and the remainder, 1,568 tons, was milled and produced 392 tons of concentrates. In 1917 the output of the district was 35,945 tons of ore, valued at $452,903. The most important production of the district came from the Mount Washington mine, operated by the Angelica Mining & Development Co., and consisted of several thousand tons of sulphide lead ore containing gold and silver. The mine is opened to a depth of 800 feet by a 3,600-foot adit. Lead ore was also shipped from the Alta & Custer, Black Jack, and Alta Gregory properties and copper ore from the Boston & Corbin, Daily, and Blue Bird mines.

Elkhorn district.—Seven deep mines produced 6,437 tons of ore, containing $5,632 in gold, 67,585 ounces of silver, 10,185 pounds of copper, and 12,960 pounds of lead, valued in all at $76,653, or an average value per ton of $11.91. The output in 1917 was 5,910 tons of ore, valued at $42,521. Nearly all of the output was old tailings from the Elkhorn group, which became a valuable shipping product on account of the increase in the price of silver. Several shipments of copper ore were made from the Elkhorn Bulwer property and oxidized iron ore from the Golden Curry mine.

Lump Gulch district.—Three deep mines and 1 placer near Clancey produced 156 tons of ore, $278 in gold, 14,987 ounces of silver, and 19,227 pounds of lead, valued in all at $16,630. Some gold was recovered by sluicing operations at the Botkin placer, 9 miles from Clancey. The Free Coinage property produced lead ore containing a large percentage of silver. Small shipments also came from the Dan Tucker and Legal Tender properties.

Mitchell district.—A small test shipment of gold ore was made from the John property, operated by the Economy Mines Co. Ore was being blocked out for a 125-ton concentration mill which was under construction during the year.

Warm Springs district.—A shipment of oxidized lead ore was made from the Middlesex property, near Alhambra.

Whitehall district.—Ten deep mines produced 490 tons of ore, containing $11,333 in gold, 4,530 ounces of silver, 24,517 pounds of copper, and 49,547 pounds of lead, valued in all at $25,437, or an average value per ton of $51.91. With the exception of 13 tons of gold ore milled, the entire product was of shipping grade. In 1917 the output was 972 tons, valued at $38,220. The largest output was copper ore from the Eighty Acre mine and an oxidized lead ore from the Milburn property. Smaller shipments came from the Ironsides, I. W. W., Croatia, and Martin properties.

LEWIS AND CLARK COUNTY.

Mine production in Lewis and Clark County, Mont., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Placers:								
1917	17	....	$6,213	56	....	....	....	$6,259
1918	15	....	5,503	79	....	....	....	5,582
Deep mines:								
1917	77	77,659	866,316	156,051	28,805	1,199,868	31,145	1,109,132
1918	42	58,921	628,994	135,308	7,025	726,520	....	817,620
Decrease, 1918	....	18,738	238,032	20,720	21,780	473,348	31,145	292,189

The output of ore reported by 42 producers in Lewis and Clark County in 1918 was 58,921 tons, a decrease of 18,738 tons. The total average value per ton decreased from $14.28 in 1917 to $13.88 in 1918, but the gold and silver value increased from $12.81 to $12.97. In gold and silver mills, 42,435 tons of ore and 11,500 tons of old tailings were treated, principally by cyanidation, and yielded bullion containing $519,791 in gold and 62,849 ounces of silver, or an average value per ton of $10.80. Only 10 tons was treated in concentration mills, but crude shipping ore aggregated 4,976 tons and contained $109,018 in gold, 72,385 ounces of silver, 6,489 pounds of copper, and 725,423 pounds of lead, valued in all at $234,511, or an average value per ton of $47.13. Of the total quantity, 55,493 tons was siliceous ore, 2 tons copper ore, 3,332 tons lead ore, and 94 tons copper-lead ore. The placer output of 15 producers amounted to $5,503 in gold and 79 ounces of silver, against $6,213 in gold and 56 ounces of silver in 1917. The only active lead smelting plant in Montana is at East Helena. Custom lead ore and concentrate from Idaho, Montana, and British Columbia were smelted during 1918, and the bullion shipped to Omaha, Nebr., for refining. The plant consists of sampling mill, Godfrey roasting furnaces, H. & H. pots, 6 Dwight Lloyd sintering machines, 4 blast furnaces, Cottrell plant, and bag house. The maximum capacity is 900 tons of charge per day.

Bald Butte district.—Several hundred tons of gold ore from the Bald Butte mine was treated in the 40-stamp mill by amalgamation and concentration. The important output of the district, however, came from the treatment of old tailings originally from the Bald Butte property. These were treated by cyanidation by the Tower & Templeman Leasing Co.

Dry Gulch district.—Four placers produced $796 in gold and 4 ounces of silver. This output includes some gold from New York Gulch and Magpie Gulch.

Greenhorn district.—The Evans-Jones placer produced a few ounces of gold.

Helena district.—Six deep mines and 4 placers produced 1,270 tons of ore, $5,076 in gold, 16,385 ounces of silver, 187 pounds of copper, and 280,662 pounds of lead, valued in all at $41,434. The ore had an average value per ton of $31.90. In 1917 the value of the output of the district was $67,145. A large part of the output was sulphide lead ore from the Helena mine, formerly operated by the Helena Mining Bureau. Other shipments of lead ore came from the Horn Lode and Rock Rose properties. Small lots of placer gold were purchased from this district, but the Humboldt placer was the only one which reported operations.

Lincoln district.—The Harvey placer was operated for five months during the year and made a small production by ground sluicing. The Mike Horse mine, which produced some lead ore of milling grade in 1917 did not produce in 1918. The proposed line of the Chicago, Milwaukee & St. Paul Railway connecting Great Falls and Missoula will, when completed, pass through this district. The expense of hauling concentrate by teams will thus be eliminated.

Ottawa district.—Nine deep mines and 1 placer produced 46,675 tons of ore and old tailings, containing $497,573 in gold, 62,239 ounces of silver, 5,104 pounds of copper, and 73,731 pounds of lead, valued in all at $566,308. The ore had an average value per ton of $12.13. Cyanidation mills treated 41,488 tons of ore and 5,000 tons of old tailings. The remainder, 187 tons, was shipped to smelting plants. In 1917 the mines of the district produced 56,565 tons of ore, valued at $768,048. The largest part of the output came from the Shannon and Piegan-Gloster mines, operated by the Barnes King Development Co. According to the report [1] of the company,

> At the Piegan-Gloster mine there was a labor shortage for the greater part of the year and the development work amounted to but little more than half that for the year 1917.
>
> The 500 level of the Gloster was advanced 937 feet westerly, cutting four ore shoots with a combined length of about 350 feet. * * *
>
> Ore reserves on the first of the year were estimated at 2,835 tons, of an average value of $7.30 per ton.

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[1] Barnes King Development Co. Ann. Rept. for year ending Dec. 31, 1918.

Production to date.

Year.	Quantity (short tons).	Value per ton.	Bullion sales.
1915	14,956	$7.22	$85,533.39
1916	22,144	6.15	133,587.90
1917	20,525	10.43	210,310.92
1918	15,338	9.21	141,326.60

The gold was valued at $107,356 and the silver at $34,656. * * *

The Shannon property was operated continuously during the year, but shipments over the tramway to the Gloster mill were interrupted for half the month of November, due indirectly to the influenza epidemic.

Sinking of the main shaft to the 650 level was completed early in the year and drifting on the vein started at that level. It was opened for a distance of 620 feet west of the shaft, but of this distance not over 100 feet was found to be of milling value. * * *

On the 500 level a new ore shoot was opened for a distance of 400 feet, which appears to be distinct from the main Shannon vein. It was raised on for 100 feet and connection made with the 400 level by extending the latter westerly and drifting east from the top of the raise. * * *

The production for the last three years is as follows:

Year.	Quantity (short tons).	Value per ton.	Bullion sales.
1916	13,392	$13.94	$180,485.69
1917	32,359	15.17	492,683.74
1918	26,048	13.02	349,138.35

Ore reserves are estimated at 30,700 tons, of $11.30 grade.

In May, an option was taken on the Mount Pleasant group of two claims, conveniently situated about 3,000 feet east of the Shannon.

Dividends paid in 1918 from the profits of all property of the Barnes King Development Co. were $160,000.

The Drumlummon mine was not operated during the year, but several thousand tons of tailings were treated by lessees. The Cruse & Bald Mountain property, formerly a producer of gold bullion, was practically idle during the year. A small output of gold bullion was the result of operations of a new 5-stamp mill on the Lucky Girl property, at Marysville. Several shipments of lead ore were made from the Towsley & Nile mine.

Scratch Gravel district.—Seven deep mines produced 1,185 tons of ore, containing $92,594 in gold, 19,742 ounces of silver, 348 pounds of copper, and 31,778 pounds of lead, valued in all at $114,678, or an average value per ton of $96.77. In 1917 the output of the district was valued at $139,975. Several hundred tons of gold ore were shipped from the Franklin mine, but the output was by no means as large as in former years. Unusually rich gold ore came from the Scratch Gravel mine, but the property was closed in October. Several shipments of oxidized lead ore were made from the Silver Coin property, and other shipments came from the Katie and Sam & Summit properties.

Seven Mile district.—A small shipment of siliceous ore was made from the Saginaw property.

Springhill district.—A small placer production resulted from hydraulic operations on the Skelly Gulch placer, near Austin. There was also a shipment of lead ore from the Stanton mine.

Stemple district.—Five deep mines and 1 placer produced 299 tons of ore, $2,820 in gold, 1,093 ounces of silver, 449 pounds of copper, and 20,955 pounds of lead, valued in all at $5,512. The ore had an average value per ton of $16.95. At the Bell Boy property some gold ore was treated by amalgamation and one shipment of lead ore was sent to the smelter. Gold ore from the old dump at the at the Alpha & Omega property was treated by cyanidation.

Unionville district.—Several hundred tons of dump ore from the Whitlatch mine were treated by amalgamation, but a large part of the gold was lost in milling.

Vaughn district.—Eight deep mines and 1 placer produced 2,430 tons of ore, $12,725 in gold, 32,788 ounces of silver, 850 pounds of copper, and 310,883 pounds of lead, valued in all at $67,796. The ore had an average value per ton of $27. In 1917 the output was 6,644 tons of ore, valued at $48,441. The larger part of the output was sulphide lead ore from the Lee Mountain and Valley Forge mines, at Rimini. The Peerless Jennie produced several hundred tons of siliceous silver ore. Smaller shipments were made from the Monte Cristo, Nick, and Nellie Bell properties. The Porphyry Dyke mine, formerly an important producer of gold from low-grade ore, was idle most of the year. A fair production of placer gold came from the Perseverance property.

Wolf Creek district.—A test shipment of silver ore was made from the Liberty property, near Wolf Creek.

LINCOLN COUNTY.

Two deep-mine operators reported 65,412 tons of ore, valued at $829,618, or an average value per ton of $12.68. Most of the output was lead-zinc ore, which was concentrated and separated into a lead concentrate and a lead-zinc concentrate. A small part (70 tons) was treated by amalgamation. One placer operator reported a small production. These mines are situated in the north western section of the State. Several other properties of merit were idle on account of the unusual expense of mining.

Libby district.—A little bullion, containing gold and silver, was produced by the Rose Consolidated Copper Co. The output was small, however, compared with the production of 1917.

Troy district.—The Snow Storm Mines Consolidated, at Troy, produced a large quantity of lead-zinc ore. The printed report [1] of the company contains the following paragraphs:

> During the year we mined and milled 65,342 tons of ore, containing 1,045 ounces of gold, 187,531 ounces of silver, 9,394,638 pounds of lead, and 8,121,925 pounds of zinc; and shipped the following concentrates:
>
> Lead concentrates, 5,093 tons, containing 561 ounces of gold, 126,077 ounces of silver, and 5,864,174 pounds of lead; zinc concentrates, 3,644 tons, containing 38,528 ounces of silver, 1,196,310 pounds of lead, and 2,474,969 pounds of zinc. * * *
>
> The plant and equipment of your company is in good physical condition, but economic conditions generally must become more favorable to the mining industry before we can hope to substantially increase our earnings.
>
> The income from concentrates was $460,245 and the net profit for the year, exclusive of charge for depreciation, was $47,314.

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[1] Snow Storm Mines Consolidated Ann. Rept. for year ending Dec. 31, 1918.

MADISON COUNTY.

Mine production in Madison County, Mont., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Placers:								
1917	6		$413,570	3,136				$416,154
1918	8		336,156	2,611				338,767
Deep mines:								
1917	97	14,520	87,133	34,831	77,012	428,999		173,752
1918	62	9,451	56,928	40,235	54,904	437,205	11,114	142,777
Increase or decrease, 1918		−5,069	−107,619	+4,879	−22,108	+8,206	+11,114	−108,362

Sixty-two deep-mine operators in Madison County in 1918 reported the production of 9,451 tons of ore, a decrease of 5,069 tons from the output of 1917. The total average value per ton increased from $11.97 in 1917 to $15.11 in 1918, and the gold and silver value from $7.98 to $10.28. The larger part of the ore (4,830 tons) was treated at concentration mills and yielded 489 tons of concentrates, valued at $38,846, or an average value per ton of $79.44. There was 1,958 tons of ore treated at gold and silver mills, which, with 1,200 tons of tailings, yielded bullion containing $21,930 in gold and 13,095 ounces of silver, or an average value per ton of $11.09. There was 1,463 tons of ore shipped, valued at $68,909, or an average value per ton of $47.10. Of the ore mined, 5,400 tons was classified as dry or siliceous ore, 471 tons as copper ore, 3,499 tons as lead ore, and 81 tons as lead-zinc ore. Placer bulion reported by 8 producers amounted to $336,156 in gold and 2,611 ounces of silver, against a placer output by 6 producers of $413,570 in gold and 3,136 ounces of silver in 1917.

Alder Gulch district.—Four deep mines and 2 placers near Virginia City produced 27 tons of ore, $335,375 in gold, 2,787 ounces of silver, and 224 pounds of copper, valued an all at $338,217. The ore had an average value per ton of $32.11 and then placer output contained $334,750 in gold and 2,600 ounces of silver. Most of the production came from dredge operations by the Conrey Placer Mining Co., which operated two dredges the entire year and a third dredge for four months. Nearly all the placer gravel has now been worked, and the output was considerably less than during 1917. Some test shipments were made from the Dewdrop, Metallic, and Iron Hat properties, and ore was also treated by amalgamation at the Metallic mine.

Lower Hot Springs district.—A small shipment of siliceous silver ore was made from the Morning Star mine, near Norris.

McCarthy district.—Four deep mines produced 103 tons of ore, containing $101 in gold, 5,882 ounces of silver, 206 pounds of copper, and 37,873 pounds of lead, valued in all at $8,723, or an average value per ton of $84.68. The Pollyanna, Windy, and Cinch properties produced small shipments of lead ore, and several shipments of siliceous silver ore were made from the Vermont mine.

Mineral Hill district.—Five deep mines produced 1,069 tons of ore, containing $8,078 in gold, 242 ounces of silver, and 52 pounds of copper, valued in all at $8,333, or an average value per ton of $7.80. The Ned mine, at Pony, produced some rich gold ore of shipping grade. Ore was treated from the Boss Tweed & Clipper property, which has a 15-stamp mill equipped for amalgamation and concentration.

Rabbit district.—Three deep mines and 1 placer produced 38 tons of ore, $164 in gold, 742 ounces of silver, 138 pounds of copper, and 16,808 pounds of lead, valued in all at $2,134. Small shipments of lead ore were made from the Cooper, Emma, and Good Friday mines, at Rochester.

Ramshorn district.—Two deep mines and 4 placers produced 415 tons of ore, $2,260 in gold, 266 ounces of silver, and 42,134 pounds of copper, valued in all at $12,933. The ore had an average value per ton of $27.93, and the placer output was valued at $1,344. Several hundred tons of oxidized copper ore was shipped from the Bella Union and Dictator mines. The Camp Bird placer, in California Gulch, was operated by the hydraulic method.

Sheridan district.—Sixteen deep mines produced 3,693 tons of ore, $9,456 in gold, 6,618 ounces of silver, 604 pounds of copper, and 189,355 pounds of lead, valued in all at $29,667, or an average value per ton of $8.03. Several hundred tons of gold ore was treated by amalgamation at the Tamarack property, and a large quantity of lead ore was milled at the Baker & Gaebelin mine. Smaller shipments were made from the Allie, Deutschland, Diadem, Flagstaff, Jessie, North Extension, Silver Bar, and Sunnyside claims. At the Lake Shore property improvements were made preparatory to operating the cyanidation plant.

Silver Star district.—Seven deep mines produced 119 tons of ore, $733 in gold, 853 ounces of silver, 3,533 pounds of copper, and 2,207 pounds of lead, valued in all at $2,616, or an average value per ton of $21.98. Nearly all the ore was of shipping grade and came from the Broadway, Columbia, Mucilage, Silver Star, and Combination properties.

Summit district.—Six deep mines and 1 placer produced 1,840 tons of ore, $15,305 in gold, 16,517 ounces of silver, and 173 pounds of lead, valued in all at $31,834. The ore had an average value per ton of $17.27. At the Easton-Pacific property several hundred tons of old tailings, containing gold and silver, were treated by cyanidation. The Winnetka mine produced rich gold ore, some of which was milled and the remainder shipped as first-class product. Several shipments of ore, rich in both gold and silver, were made from the Black Rock property, and some ore was milled at the Highland mine. The Mountain Chief mine, in Williams Gulch, was not operated, but some ore taken out in 1917 was treated by amalgamation.

Tidal Wave district.—Eleven deep mines produced 2,101 tons of ore, containing $18,937 in gold, 7,959 ounces of silver, 7,681 pounds of copper, 190,789 pounds of lead, and 11,114 pounds of recoverable zinc, valued in all at $43,350, or an average value per ton of $20.63. Most of the ore, or 1,730 tons, was milled and produced 287 tons of concentrates. The remainder was shipped as crude ore. The 50-ton mill on the B. & H. property was operated for about four months and made a concentrate containing principally gold. The ore also contained zinc, and a shipment of lead-zinc concentrate was made as a test. Lead ore was shipped from the Aparanda, Ella, Bay State, Sunflower, Van Meter Lode, and Texas properties. A test shipment of rich gold ore came from the Wild Cat property.

Upper Hot Springs district.—The Galena and Boaz properties produced small shipments of gold ore.

Washington district.—The Lehigh Gold Mining Co., at Norris, made a shipment of ore containing several ounces of gold per ton. A 10-stamp mill and cyanide plant, constructed at the Missouri & McKee property, were ready for operation at the close of the year.

MEAGHER COUNTY.

Five mines produced 157 tons of ore, containing gold, silver, and copper, valued at $12,139, or an average value per ton of $77.32. All the output was copper ore of shipping grade. No placers were productive. In 1917 seven mines produced 873 tons of ore.

Murray district.—Shipments of copper ore were made from the property of the Willis Copper Co., at Calkins.

Musselshell district.—Small shipments of copper ore were made from the Copper Duke, Copper Hill, and Virginia properties near Delpine.

MINERAL COUNTY.

Four deep-mine producers in 1918 reported 19,983 tons of ore, valued at $128,639, or an average value per ton of $6.44. This output consisted almost entirely of copper ore (19,935 tons), most of which was milled and yielded 1,834 tons of copper concentrate. The crude ore shipped aggregated 133 tons and was valued at $5,012, an average value per ton of $37.68. The placer bullion reported by 13 producers amounted to 10,911 in gold and 18 ounces of silver, against a production of $7,031 in gold and 10 ounces of silver reported by 16 producers in 1917.

Cedar Creek district.—One deep mine and 13 placers produced ore and bullion valued at $134,451. The placer bullion contained $10,911 in gold and 18 ounces of silver. The principal sluicing operations were carried on at the Ohio Gulch, C. B. & Q., and Windfall placers. The Meadow Creek property was operated by drifting, and the Cedar Creek property was worked by the hydraulic method, since the dredge formerly operated was removed. Copper concentrate was shipped from the Amador mine, owned by the Intermountain Copper Mining Co. Tube mill and Wilfley tables were added to the milling plant, and much new ore is said to have been opened.

Iron Mountain district.—A shipment of sulphide lead-zinc ore was made from the Iron Mountain mine at Superior. This property was a producer in past years, but is now closed and the milling plant has been dismantled.

St. Regis district.—Development work was in progress at the St. Lawrence mine, and a few shipments of low-grade copper ore were made as a test. The property has a vertical shaft 112 feet deep and 1,200 feet of drifts.

Saltese district.—At the Tarbox mine a large quantity of lead-zinc ore was opened by shaft, which has reached the 1,000-foot level. A concentration mill is planned.

MISSOULA COUNTY.

Three deep mines produced 177 tons of ore, a decrease of 511 tons. The output consisted of 63 tons of copper ore and 114 tons of lead ore; it was of shipping grade and contained $255 in gold, 9,017 ounces of silver, 16,690 pounds of copper, and 16,600 pounds of lead, valued in all at $14,573, or an average value per ton of $82.33. Five placers produced bullion containing $1,193 in gold and 4 ounces of silver.

Coloma district.—One deep mine and 3 placers produced 114 tons of ore, $906 in gold, 8,968 ounces of silver, 491 pounds of copper, and 16,600 pounds of lead, valued in all at $11,174. Several shipments of lead ore, containing considerable silver, were made from the Royal property, near Potomac. Sluicing operations were carried on at the Elk Creek placers. The ore deposits of this district and the Copper Cliff district are described by J. T. Pardee.[1]

Copper Cliff district.—The Leonard and Copper Queen mines, near Bonita, produced several shipments of copper ore. Later the claims were sold to the Potomac Copper Mining Co.

Nine Mile district.—Gold was won by sluicing at the Petty Creek and Tom Tom placers, near Stark.

PARK COUNTY.

Four deep mines in Park County produced 3,630 tons of ore in 1918, an increase of 3,465 tons. The ore had an average value per ton of $7.52 in gold, silver, and lead, and a value of $6.67 in gold and silver. There were 3,554 tons of siliceous ore and 76 tons of lead ore. Most of the ore (3,500 tons) was milled and made gold bullion and a rich gold concentrate. The remainder was shipped directly to smelters. Two placers produced $583 in gold and 4 ounces of silver.

Emigrant Creek district.—The Pittsburg placer was operated by the Chico Mining Co. Much development work was done on the Upper Falls placer, preparatory to drift mining.

New World district.—Several shipments of lead ore were made from the Greeley and Yellowstone properties, near Cooke.

Sheepeater district.—Several thousand tons of gold ore from the property of the Jardine Gold Mining & Milling Co., were treated in a mill using amalgamation and concentration. Some crude ore was shipped, but most of the gold was produced from concentrates. The property also produced a small quantity of scheelite.

PHILLIPS COUNTY.

Little Rockies district.—Properties in this district at Whitcomb, near Zortman, suffered from labor troubles and the high cost of material and supplies. The mines and mills are 50 miles from Dodson on the Great Northern Railway, and the ore is very low-grade material. The Ruby Gulch property was operated for only a few months of the year, and the August Mining Co., was practically idle. In 1917 the district had an output of 219,350 tons of ore and 4,000 tons of old tailings, which were treated by cyanidation and resulted in a recovery of $1.94 per ton in gold and silver. The geology of this region was described in a recent publication.[1]

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[1] Pardee, J. T., Ore deposits of the northwestern part of the Garnet Range, Mont.: U. S. Geol. Survey Bull. 660, pp. 159-239, 1918.

POWELL COUNTY.

Eighteen producers reported in 1918 an output of 1,018 tons of ore, which was 1,127 tons less than was produced by 14 operators in 1917. The total value per ton increased from $10.78 in 1917 to $22.62 in 1918, and the gold and silver value per ton from $6.24 to $13.11. Thirteen tons of ore and 600 tons of tailings were milled and produced bullion containing $2,575 in gold and 104 ounces of silver. The ore shipped directly to the smelter aggregated 405 tons, containing $2,679 in gold, 7,984 ounces of silver, 6,072 pounds of copper, and 115,244 pounds of lead, valued in all at $20,345, or an average value per ton of $50.23. The material was classified as 686 tons of siliceous ore and old tailings, 286 tons of lead ore, and 46 tons of copper ore. Fifteen placer producers reported $8,379 in gold and 57 ounces of silver in 1918, against an output of $14,194 in gold and 84 ounces of silver in 1917 by 17 producers.

Mary Ann district.—A small quantity of lead ore was shipped from the Gray Rock and Marian mines, near Elliston.

Ontario district.—Six deep mines and 1 placer produced 145 tons of ore, $2,011 in gold, 2,681 ounces of silver, and 39,093 pounds of lead, valued in all at $7,467. The ore had an average value per ton of $50.10. Shipments from the district consisted of lead ore from the Black Jack, Charter Oak, Lizzard, Finland, and Parson mines.

Ophir district.—Six deep mines and 5 placers produced 702 tons of ore, $3,934 in gold, 741 ounces of silver, and 2,332 pounds of copper, valued in all at $5,251. The ore had an average value per ton of $6.45, and the placer output was valued at $726. Most of the gold was the result of milling operations at the Victory mine, where tailings were treated by cyanidation. A shipment of copper ore was made from the Audrey May mine, and some gold and silver ore came from the Fairview property. The Prairie and Carpenter Bar placers, 9 miles northeast of Avon, were worked by hydraulic giants.

Pioneer district.—Six placers produced $6,542 in gold and 45 ounces of silver. Although the output has been decreasing for several years, the Pioneer placer is still the most important of those worked in this district. Considerable gold also came from the Upper Gold Creek, Oro Fino, and Friday placers.

Snowshoe district.—The Arnold mine, near Avon, was operated during the greater part of the year and one shipment of copper ore was made to the Pittsmont smelter at Butte.

Washington district.—The Fontana and Small Nugget placers, near Finn, were the only productive properties in the district.

Zozell district.—A small shipment of siliceous silver ore was made from the Emery Consolidated property, west of Deer Lodge.

RAVALLI COUNTY.

Curlew district.—The concentration plant of the Victor Reduction Co., which formerly treated lead-zinc tailings, was idle during most of 1918. A shipment of concentrate from former operations was made in the early part of the year.

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[1] Collier, A. J., Geology of northeastern Montana: U. S. Geol. Survey Prof. Paper 120, pp. 17-39, 1918.

Hughes Creek district.—The placer product from this region contained $4,453 in gold and 18 ounces of silver, the most of which came from hydraulic operations on the ground of the Wood Placer Mining Co.

SANDERS COUNTY.

Six deep-mine producers reported the output of 485 tons of ore, containing $171 in gold, 5,690 ounces of silver, 36,824 pounds of copper, and 25,796 pounds of lead, valued in all at $16,787, or an average value per ton of $34.61. The output was 519 tons less than that of 1917 and consisted of 365 tons of copper ore and 120 tons of lead ore.

Revais Creek district.—A few shipments of copper ore were made from the Dixon mine.

Spring Gulch district.—The King and Queen mines, near Superior, were operated by the Pitt Copper Mining Co. The mill, having a capacity of 100 tons per day, was not active, but crude ore, mostly sulphide copper ore, was marketed.

SILVER BOW COUNTY.

Mine production in Silver Bow County, Mont., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	56	5,681,058	$690,801	11,511,600	270,592,901	10,352,453	180,316,415	$103,330,806
1918	75	7,394,038	902,094	15,013,855	321,107,456	22,746,456	204,963,778	115,496,193
Increase, 1918		1,712,980	211,293	3,502,255	50,514,555	12,394,003	24,647,363	12,165,387

[a] Includes placer production.

Sixty-nine deep mines in Silver Bow County produced 7,394,038 tons of ore in 1918, nearly all of which was mined from property in the Butte or Summit Valley district. Most of this output was produced by 17 companies. The total average value per ton decreased from $18.19 in 1917 to $15.62 in 1918, but the gold and silver value per ton increased from $1.79 to $2.15. The gold produced from both deep mines and placers increased in value from $690,801 in 1917 to $902,094 in 1918, the silver from $9,485,558 to $15,013,855, the copper from $73,871,862 to $79,313,542, the lead from $890,311 to $1,614,998, and the zinc from $18,392,274 to $18,651,704. The total value of all metals increased from $103,330,806 in 1917 to $115,496,193 in 1918. The largest part of the ore produced, 5,857,347 tons, and 519,043 tons of old tailings were concentrated at milling plants situated at Butte and Anaconda. The product consisted of copper concentrates, zinc concentrates, lead-zinc concentrates, lead concentrates, and siliceous concentrates, aggregating 2,032,215 tons and containing $804,358 in gold, 13,189,078 ounces of silver, 273,318,935 pounds of copper, 22,743,202 pounds of lead, and 204,943,068 pounds of zinc, valued in all at $101,767,799, or an average value per ton of $50.08. The crude smelting ore amounted to 393,068 tons and contained $88,366 in gold, 1,610,896 ounces of silver, 34,453,257 pounds of copper, 3,254 pounds of lead, and 20,710 pounds of zinc, valued in all at $10,211,331, or an average value per ton of $25.98. Only a few tons of ore were treated in gold and silver mills, but 68,502 tons of copper ore and 519,200 tons of old tailings were leached with sulphuric acid. The output of ore was classified as 6,380,426 tons of copper ore, 996,856 tons of lead-zinc ore, 1,873 tons of zinc ore, 14,882 tons of dry or siliceous ore, and 1 ton of lead ore. The placer output was $3,012 in gold and 28 ounces of silver, as against $3,658 in gold and 22 ounces of silver in 1917. Silver Bow County produced more than 94 per cent of the output of ore in the State, about 29 per cent of the gold, nearly 90 per cent of the silver, more than 99 per cent of the copper, more than 61 per cent of the lead, about 98 per cent of the zinc, and more than 95 per cent of the total value.

Divide Creek district.—Several shipments of copper ore and silver ore were made from the Combination, Silent Tracery, and Alice claims. A shipment of silver ore also came from the Daisy mine, near Melrose.

German Gulch district.—The Beal placer was worked by hydraulicking for about thirty days.

Highland district.—Placer output came principally from drifting operations at the Highland placer, owned by the Butte Water Co. The Brooks mine produced a small shipment of siliceous silver ore.

Summit Valley or Butte district.—Since the beginning of activities in 1882 to the end of 1918, Silver Bow County, of which this district covers the largest part, has produced gold, silver, copper, lead, and zinc valued at $1,563,133,756, divided as follows: Gold, $30,292,107; silver, $238,263,286; copper, $1,182,395,763; lead, $4,236,175. In 1905 the production of zinc began, and to the end of 1918 the value amounted to $107,946,425. The values given above are for 1,465,380.64 ounces of gold, 339,617,854 ounces of silver, 7,593,618,062 pounds of copper, 66,911,253 pounds of lead, and 1,115,919,464 pounds of recoverable zinc. A statement of the figures by years to 1913 may be seen in Mineral Resources for that year.

Mining in the district, and especially in the western part, was stimulated in 1918 by the price of silver and the demand for manganese, the deposits of which were described in a recent bulletin.[1] Work was not interrupted in 1918 by labor strikes, though it was difficult to obtain the necessary number of experienced men. In July wages were raised 50 cents per shift and more than 16,000 men at Butte were thus affected. In November there was a decided change in market conditions, and early in 1919, when there was practically no market for copper, the output of the district was reduced to a 50 per cent basis and all wages were cut $1 a day.

The mines of the Anaconda Copper Mining Co.[2] produced 4,918,468 tons of ore and 6,554 tons of precipitates, a total of 4,925,022 tons, against a total of 4,203,636 tons in 1917. The copper reduction works treated for all companies during the year 4,959,580 tons of ore and other cupriferous material at Anaconda, and 57,000 tons of ore and other cupriferous material at Great Falls. Of this quantity 4,350,446 tons of ore was produced by company mines, 618,256 tons of ore was either purchased from or treated for other companies, and 47,878 tons of precipitates and cleanings from the old works at Anaconda and Butte were treated. The Anaconda works produced

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[1] Pardee, J. T., Manganese at Butte, Mont.: U. S. Geol. Survey Bull. 690, pp., 111-130, 1919.
[2] Anaconda Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

279,030,318 pounds of fine copper, 10,001,604.81 ounces of silver, and 59,403.116 ounces of gold; the Great Falls works produced 14,573,408 pounds of fine copper, 966,300.31 ounces of silver, and 4,914.506 ounces of gold—or a total production at both Anaconda and Great Falls of 293,603,726 pounds of fine copper, 10,967,905.12 ounces of silver, and 64,317.622 ounces of gold. Of the total production at these plants, 272,923,031 pounds of fine copper, 10,076,747.98 ounces of silver, and 64,317.622 ounces of gold were produced for the Anaconda Co. The electrolytic copper refinery at Great Falls produced, during the year, 191,404,125 pounds of cathodes, 189,067,167 pounds of which were melted into shapes at Great Falls. The copper-leaching plant at Anaconda treated, during the year, 500,688 tons of tailings, and 64,978 tons of copper ore, from which 6,662 tons of cement copper was produced. The zinc plants at Anaconda and Great Falls treated during the year 393,193 tons of ore and other zinciferous material, of which 255,057 tons was produced by mines of the Anaconda Co., and 138,136 tons of ore and concentrates were purchased from other companies. At Great Falls 72,131,238 pounds of electrolytic zinc was produced during the year. The plant was operated continuously with excellent results, as every effort was made to secure as great an output as possible, in order to meet the requirements of the Government. The zinc produced, on account of its purity, was used largely in munition work. The company report continues as follows:

> During the year 1918, there was done in the mines of the company, in the form of drifts, crosscuts, upraises, shafts, and winzes, 41.85 miles of development, as compared with 38.61 miles in the year 1917. The shafts of the company were sunk additional depths aggregating 4,991 feet. The results of the development work were quite satisfactory. * * *
>
> The new stack at Anaconda mentioned in the last report was completed during the year, having a height of 585 feet and an inside diameter of 70 feet at the bottom and 60 feet at the top.
>
> Work on the Cottrell treaters was delayed, due to the fact that it was found to be impossible, for a time, to secure priority orders from the Government on the steel. The work is now progressing as rapidly as conditions will permit, and it is expected that the Cottrell plant will be completed some time during the coming summer.
>
> A system of three earth dams for impounding tailings was started, one of which is now in commission. Two of them will impound the tailings from the reduction works, while the third is built across the Deer Lodge Valley and will serve to clarify the waters of Deer Lodge River, which at present contain impurities coming from the Butte district.
>
> In order to secure additional roaster capacity for the zinc plant at Great Falls, 14 of the 28 roasting furnaces for the copper leaching plant were remodeled for roasting zinc concentrates.
>
> Two earth dams, across the ends of Silver Lake, were started for the purpose of increasing water storage.
>
> An experimental 25-ton acid plant was started in November in order to test out a new method of making sulphuric acid.
>
> The rod and wire mill at Great Falls was completed during the summer, and the rod mill was put in operation on June 9, and both were in continuous operation during the latter part of the year.
>
> Considerable difficulty was experienced in obtaining skilled operators for both the rod and wire mills, but by the end of the year both departments were operating in a satisfactory manner.
>
> As a result of experience gained in operating the various departments of the zinc plants of the company, it was found that by the expenditure of a proportionately small sum of money, the output of the electrolytic zinc plant at Great Falls could be increased from 100 to 150 tons per day, making it possible to secure a more complete utilization of all equipment at Anaconda and Great Falls, and also reduce the cost of production; accordingly, necessary construction was begun, equipment orders

placed, and at the close of the year, the increase in the plant had been almost completed.

At the solicitation of the United States Government, five electric ferromanganese furnaces were installed at Great Falls, one of which was started in September, and two more went into commission in October and November. The furnaces had a capacity for treating 250 tons of manganese ore per day, and up to the time of the armistice, had produced upwards of 1,000 tons of ferromanganese, made from ores purchased from the Butte Copper & Zinc Co. As the demand for ferromanganese ceased with the signing of the armistice, the furnaces were shut down.

An electric furnace was installed in the casting department of the zinc plant and is operating quite satisfactorily in melting cathodes, superseding the use of reverberatory furnaces for that purpose.

Dividends paid in 1918 by the Anaconda Co. amounted to $17,484,375.

From the North Butte property[1] 461,366 wet tons of ore and 22½ wet tons of precipitates were shipped, and 453,338 dry tons of ore and 18½ dry tons of precipitates were treated at the smelter. Of this ore 57 dry tons, or 0.01 per cent, was first class, 375,359 tons, or 82.80 per cent, second class, and 77,922 dry tons, or 17.19 per cent, third class. The production was 20,680,695 pounds of fine copper, 891,157.14 ounces of silver, and 1,374.83 ounces of gold. The report continues as follows:

> The Granite Mountain shaft was in continuous operation from the middle of February, when repairs were completed and hoisting resumed, until the end of the year. The Speculator shaft was in operation throughout the year. Production and development work was on a limited scale during January and February, while the repair work at the Granite Mountain shaft was in progress. Owing to shortage of skilled labor, due to the circumstance that so many Butte men were in military service, it was necessary to employ and train a large number of new men who were unskilled in mining work. Because of this and because of large advances in wages, prices of supplies, and freight rates, costs of production were unavoidably high. * * *
>
> Development work to the extent of 23,046 feet was prosecuted energetically throughout the year, and resulted in opening up considerable tonnages of ore. * * *
>
> Your company receives its copper from the refinery three to four months after it is shipped to the smelter, consequently there is always three to four months' production which is copper in process. As all copper had to be handled up to December 31, 1918, through the War Industries Board, producers could not protect themselves by making individual contracts for future delivery of this copper in process. The effect of this policy, as compared with selling on an open market, is shown by comparing the position of your company as to copper sales on January 1, 1917, and January 1, 1919. On the former date, when there was an open market, your company not only had its entire stock of copper in process sold, but had oversold 4,504,200 pounds to be produced from ore not even mined, making a total of 11,233,766 pounds already sold, none of which had on that date been delivered by the refinery. On January 1, 1919, not a single pound of copper in process had been sold, and, in addition, your company had on hand 1,616,870 pounds of finished copper ready for delivery.

Dividends amounting to $430,000 were paid in 1918 by the North Butte Mining Co., against $1,075,000 in 1917.

The East Butte Copper Mining Co.[2] operated the Pittsmont and Dutton mines, the copper smelting plant east of Butte, and the 800-ton concentration mill equipped with a flotation plant. In 1918 the mill and smelter treated 178,948 tons of company ore and 83,038 tons of custom ore, aside from 123,520 tons of old tailings treated in the flotation plant. The work resulted in the production of 1,419 ounces of gold, 776,818 ounces of silver, and 24,599,890 pounds of copper. The gross value of the metals shipped was $5,771,187, the net surplus $765,469, and dividends $631,097. The price received for copper was 22.1387 cents per pound and the cost of production was 19.7117 cents per pound. The Pittsmont mine has three vertical shafts, the deepest of which is 1,830 feet deep. The company report continues:

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[1] North Butte Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

[2] East Butte Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

> During the year the East Butte Copper Mining Co. paid the Pittsmont Copper Co., on account of rentals accrued, the sum of $1,000,000. The Pittsmont Copper Co. in turn purchased of the East Butte Copper Mining Co. its preferred stock, amounting to 200,000 shares at $5 par, placing same in the treasury of the Pittsmont Co. From the proceeds of this sale the East Butte Co. made to its stockholders on December 21, 1918, a capital distrubition of $1 per share, after first distributing all the undistributed surplus accumulated since March 1, 1913, in the form of a dividend of 50 cents per share. * * *
>
> The price of copper throughout the greater part of the year was fixed by the Government. Under these conditions it was impossible to sell copper in advance, and inasmuch as copper is from three to four months in process of manufacture, copper produced in September and following months remained unsold at the end of the year. * * *
>
> Mining operations during the year were crowded at the expense of development work. As a result, total drifts and crosscuts for the year amounted to 9,787 feet. The work of the year, however, has opened and developed a very good ore body in 1,860 drift, known on the higher levels as the Rossell vein. A good stope has also been opened on the 1,500 level on what is known as the 1,532 vein. In spite of the vigorous mining and restricted development work, ore developed during the year equaled, if not exceeded, the amount of ore removed. * * *
>
> The flotation plant operated satisfactorily, and in addition to treating the tailings from the concentrator, there were re-treated during the year 123,520 tons of tailings from the concentrating operations of the previous years. There were recovered from this source an average of 14 pounds of copper at a cost of $1.29 per ton of tailings treated.

The Tuolumne Copper Mining Co.,[1] which now owns 85 acres of mineral land, produced in 1918 from the Main Range mine 23,534 dry tons of ore, assaying 0.0075 ounce of gold, 8.082 ounces of silver, and 2.253 per cent of copper. The total contents were 177 ounces of gold, 190,204 ounces of silver, and 1,060,466 pounds of copper, for which the company received $248,220 from the smelter. The company report says:

> On April 22, 1918, the Tuolumne Co. acquired by purchase all of the property of the Butte Main Range Copper Co., delivering to the latter company 448,353 shares of stock of the Tuolumne Copper Co. * * *
>
> On October 28, 1918, the Tuolumne Co. acquired by purchase all of the property of the Colusa-Leonard Extension Copper Co. and the Syndicate Copper Co. delivering to the Colusa-Leonard Extension Copper Co. 239,257 shares of the stock of the Tuolumne Copper Mining Co. * * *
>
> On January 1, 1918, operations were suspended at the Tuolumne mine and this property has remained closed during the entire year. Due to high operating costs which have prevailed during the past year and the fact that the ore availaole is of low grade it was impossible to operate at a profit. This property has reached a depth of 2,600 feet, and while it is probable that valuable ore bodies will be encountered below this level the cost of further development below this level would at this time be excessive and can be done at a more opportune time.
>
> Shaft sinking was carried on at the Colusa-Leonard Extension mine as provided by the contract existing between the Colusa-Leonard Extension Copper Co. and the Tuolumne Copper Mining Co. and a total of 215 feet of 2-compartment shaft was sunk. This work was suspended, however, early in the year and after enlarging the 800 station, entailing 3,465 cubic feet of excavation, and installing an auxiliary pump development operations where suspended. Shortly thereafter the Tuolumne Co. acquired title to this property and it became unnecessary to continue sinking below the 1,200-foot level which has been reached.

The Butte & Superior mine [2] produced 468,814 tons of milling ore, slightly more than during 1917. The mill recoveries for the year averaged 92.965 per cent of the zinc contents. The direct cost of milling was $2.92 per ton of ore, an increase of 40 cents per ton, of which approximately 12 cents per ton was for increased labor due to an advance in wages of 50 cents a day effective after June. No dividends were paid in 1918, but those paid in the past amounted to $16,940,258. The report continues:

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[1] Tuolumne Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

[2] Butte & Superior Mining Co. Seventh Ann. Rept., for year ending Dec. 31, 1918.

> The total income for the year, including depletion, was $628,348, as compared with $1,987,480 for the year 1917. * * *
>
> Although the tonnage treated for 1918 was slightly in excess of that for 1917 and the grade of ore better, the financial results of operations show a great decrease as compared to those of the previous year. * * *
>
> All the ore produced during the first four months was hoisted through No. 1 shaft. On May 2, this shaft was badly wrecked by the dropping of a loaded skip in the east compartment from the surface to the 1,200-foot level. By the middle of May the damage had been sufficiently repaired so that it was possible to resume regular hoisting from and above the 1,000-foot level, but only to a limited extent from below that level. This continued until October 23, on which date hoisting here was again completely suspended until November 18, to permit of retimbering between the 700 and 800 levels. On November 18, hoisting operations were resumed and continued until December 21, on which date, owing to curtailment of operations, No. 1 shaft was closed down indefinitely. * * *
>
> Shaft No. 2 was completed to the 1,900-foot level by raising with cribbed timbering a total distance of 270 feet to connect from the 1,900 to the sump below the 1,600. * * *
>
> Shaft No. 3 was completed to a point 53 feet below 2,050 level by sinking 90 feet during the early part of the year. During the first quarter, this shaft was given a complete overhauling, the shaft timbering between the 1,000 and 1,100 levels and between the 500 and 600 being entirely replaced by cribbing. * * *
>
> There was recorded during the year 16,167 feet of drifting, 11,620 feet of crosscuts, 4,441 feet of raises, 281 feet of stations, and 950 feet of shaft raising and sinking, or a total of 33,459 feet. * * *
>
> Estimate of ore reserves, as of December 31, shows 830,000 tons, averaging 17 per cent zinc and containing 5.7 ounces of silver.
>
> The unusually large amount of exploration work and of development work necessary in connection with litigation during the year and the burden of disposing of waste therefrom prevented the performance of the normal amount of work for development of the ore bodies themselves, with a resulting decrease during the year of 229,000 tons as shown by the estimate. * * *
>
> The direct cost of mining 462,577 tons of ore during the year, due to a combination of increased wages, higher cost of principal supplies, and decreased labor efficiency was $7.19 a ton, an increase of $2.04 per ton above the average for the previous year. A satisfactory grade of ore was maintained, the zinc content being 0.46 per cent higher and the silver content 0.53 ounce higher than the averages for the previous year. * * *
>
> During the year, careful study was made with a view to improvement in milling methods, in order to offset the drop in the price of spelter and changes in the smelting contracts which greatly increased the importance of raising the grade of concentrates; special attention was given to this feature with the result that zinc concentrate production averaged 3.74 per cent higher in zinc content and 2.23 ounces higher in silver content than during the previous year, with an increase in mill recovery of 1.84 per cent. * * *

Crude ore treated and concentrates produced at Butte-Superior mill in 1918.

Ore and product.	Quantity.	Gold.		Silver.	
		Total content.	Average per ton.	Total content.	Average per ton.
	Short tons.	*Ounces.*	*Ounces.*	*Ounces.*	*Ounces.*
Crude ore, milled	468,814	6,127.960	0.013	2,970,002.70	6.335
Zinc concentrate	135,543	4,590.463	.034	2,714,834.47	20.029
Lead concentrate	2,790	111.696	.040	66,559.38	23.858

Crude ore treated and concentrates produced at Butte-Superior mill in 1918—Continued.

Ore and product.	Copper.		Lead.		Zinc.	
	Total content.	Average per ton.	Total content.	Average per ton.	Total content.	Average per ton.
	Pounds.	*Per cent.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*
Crude ore, milled	1,425,394	0.152	12,393,840	1.322	149,347,334	15.928
Zinc concentrate	1,278,948	.472	9,649,761	3.560	138,841,739	51.217
Lead concentrate	14,365	.257	2,207,190	39.557	680,767	12.200

The Emma mine, owned by the Butte Copper & Zinc Co., was operated by the Anaconda Copper Mining Co. Manganese ore was shipped to eastern steel plants and lead-zinc ore was milled at Anaconda and the concentrate leached at Great Falls. Production was confined to the 800-foot level, but early in 1919 an ore body of importance was opened on the 1,000-foot level. The following extracts are taken from the printed report.[1]

> During the past year the expectations of your officers in regard to the manganese production of your company were fully realized up to the signing of the armistice and the immediate cessation of manganese ore shipments. These shipments showed a steady monthly increase, and in November 6,000 tons were shipped in 16 days, an average of 375 tons a day. The total proceeds from operations of your property for the year 1918, in which your company participated to the extent of one-half, were $1,325,166.78, of which $207,702.52 was realized from zinc ore shipments amounting to 32,293 tons, and $1,117,464.26 from manganese ore shipments amounting to 71,364 tons. * * *
>
> During the year our company acquired for $57,000 the Butte Central property consisting of the Ophir claim, in order to give an outlet for our ores on the line of the railroad. * * *
>
> Dividends paid in 1918 amounted to $300,000.

The Elm Orlu mine was active during 1918, producing copper ore shipped to Anaconda and lead-zinc ore milled at the Timber Butte mill. Zinc concentrate was shipped to eastern plants and to Great Falls at the rate of about 4,000 tons a month, and lead concentrate was smelted at East Helena. Next to the Butte & Superior mine, it was the most important zinc producer of the district. The mine is controlled by the Clark interests, and other producing properties under the same management are the Anselmo, Moulton, Poser, Travona, and Butte Reduction Works' tailing dump. A considerable production of copper resulted from the concentration of these tailings at the Timber Butte mill. The Travona produced manganese ore, milled at Helena, and the Anselmo and Moulton mines produced large quantities of both siliceous silver ore and lead-zinc ore.

East of Butte, the Butte Bullwhacker and Butte & Duluth companies produced an oxidized copper ore, which was crushed and shipped to the copper leaching plant at Anaconda. About 3,000 tons of ore per month was shipped by each company. Both of the leaching plants at these mines were idle.

The Davis Daly Copper Co. operated the Colorado mine, in the center of the city of Butte, and the Hibernia mine, 2 miles west of Butte and produced copper from shipments of copper ore, siliceous silver ore, and lead-zinc ore. Dividends amounting to $450,000 were paid during the year. During the last quarter of 1918, when the output was somewhat curtailed, the production was 15,091 tons of ore, which yielded 100,050 ounces of silver and 2,432,010 pounds of copper. During this period the 2,100-foot level was opened and a good ore body was exposed. A statement[1] for the year ending June 30, 1918, gave the following information:

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[1] Butte Copper & Zinc Co. Second Ann. Rept., for year ending Dec. 31, 1918.

> Labor troubles have given the management the greatest concern, and at the present writing (October 9) no improvement is in sight. Wages have been increased, and with almost 100 per cent increase in price of supplies, operating costs have advanced accordingly. Ventilation has been no small item of expense. Heat on the lower levels has been intense. Arrangements were made in December, 1917, to connect by crosscut the Colorado shaft with that of the Belmont, of the Anaconda Co. The distance between the two shafts is approximately 2,500 feet, advance is slow, as the temperature in the crosscut is 100 degrees. Large and powerful fans are being put in the lower levels as a part of a permanent ventilating system. New equipment had been installed at the Colorado, notably a new electrically driven hoist and compressor. Extensive improvements are contemplated that will facilitate mining and lower costs of production. Operations at the Hibernia have been active. This is primarily a silver-zinc mine, but it contains large quantities of manganese. Mining of this ore was undertaken for a period, but on account of inability to secure acceptable treatment of the ore production was stopped. Sinking the Hibernia shaft to the 600-foot level was discontinued owing to the large inflow of water, which proved to be troublesome and expensive. This shaft has been equipped with an electrically driven hoist and compressor.

For the year ending June 30, 1918, the production of the Colorado mine was 52,996 tons of ore, 260,672 ounces of silver, and 5,894,396 pounds of copper. The Hibernia mine produced 5,724 tons of ore, containing 356 ounces of gold, 129,816 ounces of silver, 611,907 pounds of lead, and 1,316,310 pounds of zinc.

The Butte Ramsdall Copper Co. made shipments of copper ore, from which more than 1,000,000 pounds of copper was produced. Some zinc ore was also shipped for concentration at Anaconda.

Other mines in the district which produced shipments worthy of mention were the Mount Moriah, Garfield Salvador, Goldsmith, Elba, Honolulu, Illinois, Mayflower, Prospector, Preferencia, and Tiger.

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[1] Min. and Sci. Press, Nov. 30, 1918, p. 739.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEW MEXICO.

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

The total value of the gold, silver, copper, lead, and zinc produced in New Mexico from ores and gravels in 1918 amounted to $28,521,413, as compared with $34,896,936 in 1917, a decrease of $6,375,523, or more than 18 per cent. There were 128 producing mines, of which 119 were deep and 9 were placer, a decrease of 58 deep mines and a decrease of 6 placers. The yield of gold was 33,030.02 fine ounces, valued at $682,791, a decrease of 18,448.62 fine ounces in quantity and of $381,367 in value. The output of silver was 782,421 fine ounces, valued at $782,421, a decrease of 611,944 fine ounces in quantity and of $366,536 in value. The output of copper was 98,264,563 pounds, a decrease of 7,303,437 pounds; the output of lead (calculated as lead in lead bullion and lead in leaded-zinc oxide) was 8,398,239 pounds, a decrease of 710,565 pounds; and the output of zinc (calculated as metal and as zinc in leaded-zinc oxide) was 24,050,324 pounds, a decrease of 6,149,676 pounds. The value of the base metals showed a decrease of $4,548,717 for copper, of $187,082 for lead, and of $891,821 for recoverable zinc (valued at the prices assigned by the United States Geological Survey for each year). There were 4,749,784 short tons of ore sold or treated in 1918, as compared with 4,576,827 tons in 1917.

Mine production of gold, silver, copper, lead, and zinc in New Mexico, 1904–1918.

Year.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	102,339	$381,930	214,553	4,972,170	3,122,872	13,493,835	$1,961,390
1905	145,629	317,510	369,192	6,126,025	1,510,209	15,142,254	2,460,535
1906	207,691	293,019	491,127	7,028,670	2,987,369	17,292,655	3,203,739
1907	219,992	329,982	705,544	10,990,015	3,809,881	750,085	3,239,823
1908	135,434	298,757	405,044	6,112,630	873,763	3,576,516	1,525,091
1909	164,156	239,491	397,783	5,393,146	5,029,767	13,085,945	2,070,368
1910	191,865	482,424	843,987	4,614,386	4,320,841	18,088,129	2,691,080
1911	232,699	762,808	1,354,540	4,057,040	2,966,222	10,237,176	2,704,843
1912	1,352,286	784,446	1,536,701	34,030,964	5,494,018	13,566,637	8,527,955
1913	2,217,660	881,926	1,631,273	56,308,706	3,946,304	16,523,161	11,694,002
1914	2,232,853	1,171,696	1,777,445	59,307,925	1,763,641	18,403,392	11,049,932
1915	2,797,072	1,461,105	2,005,531	76,788,366	4,542,361	25,404,064	19,279,468
1916	3,870,950	1,382,480	1,766,274	92,747,289	8,214,189	36,570,649	30,827,767
1917	4,576,827	1,064,158	1,394,365	105,568,000	9,108,804	30,200,000	34,896,936
1918	4,749,784	682,791	782,421	98,264,563	8,398,239	24,050,324	28,521,413
Increase or decrease, 1918	+172,957	−381,367	−611,944	−7,303,437	−710,565	−6,149,676	−6,375,523

[a] Includes placer production.

During 1918 there were treated at amalgamating and cyaniding mills in New Mexico 70,179 tons of ore, and the bullion saved amounted to $353,097 in gold, an average value per ton of $5.03, and 264,070 ounces of silver, valued at $264,070, an average recovery of 3.76 ounces and an average value per ton of $3.76, the value in gold and silver being $617,167, an average value per ton of $8.79. The recovery as bullion per ton of ore treated in 1917 was $4.386 in gold and $4.375 in silver, a total of $8.761.

GOLD.

The recoverable output of gold from New Mexico ores and gravels in 1918 amounted to 33,030.02 fine ounces, valued at $682,791, as against 51,478.64 fine ounces, valued at $1,064,158, in 1917, a decrease of 18,448.62 fine ounces in quantity and of $381,367 in value. Colfax and Lincoln counties produced 13,267.96 fine ounces, valued at $274,273, or more than 40 per cent of the total yield of the State; Grant County produced 13,063.77 fine ounces, valued at $270,052, or nearly 40 per cent; and Socorro County (chiefly from the siliceous mines at Mogollon) produced 5,811.77 fine ounces, valued at $120,140, or nearly 18 per cent of the total.

Dry and siliceous ores yielded 20,621.04 fine ounces, valued at $426,275, or 62 per cent of the total. Copper ores contained 11,698.51 fine ounces, valued at $241,830, or 35 per cent of the total, chiefly from the Central and Lordsburg districts, Grant County. Lead ores furnished 459.44 fine ounces, valued at $9,497, chiefly from the Victorio district, Luna County, and the Magdalena district, Socorro County. Copper-lead ores furnished a small quantity of gold. The production of placer gold amounted to 150.83 fine ounces, valued at $3,118.

SILVER.

The recoverable output of silver from New Mexico ores and gravels in 1918 amounted to 782,421 fine ounces, valued at $782,421, as compared with 1,394,365 fine ounces, valued at $1,148,957, in 1917, a decrease of 611,944 fine ounces in quantity and of $366,536 in value. Of the total quantity Socorro County produced 352,878 fine ounces, or 45 per cent, chiefly from siliceous ore from the Mogollon district, the remainder from mixed ores of the Magdalena district. Grant County produced 338,833 fine ounces, or 43 per cent of the total, chiefly from the Lordsburg district. The yield of silver from Grant and Socorro counties combined was 88 per cent of the total.

Dry and siliceous gold and silver ore, chiefly from Socorro and Grant counties, yielded 377,855 fine ounces of silver, or more than 48 per cent of the total; copper ores, chiefly from Grant, Santa Fe, and Socorro counties, yielded 251,329 fine ounces, or 32 per cent; lead ores, chiefly from the central district, Grant County, the Cooks Peak and Victorio districts, Luna County, and the Magdalena district, Socorro County, yielded 116,473 fine ounces, or nearly 15 per cent; copper lead ores, chiefly from the Central district, Grant County, and the Magdalena district, Socorro County, yielded 36,317 fine ounces, or a little less than 5 per cent. Zinc ores yielded a small quantity of silver.

COPPER.

In 1918 the production of copper in New Mexico amounted to 98,264,563 pounds, valued at $24,271,347, a decrease of 7,303,437 pounds and $4,548,717, as compared with the output in 1917. Grant County, chiefly from the output of the Chino Copper Co., at Santa Rita, and from the Lordsburg and Burro Mountain districts, produced 96,939,381 pounds, or nearly 99 per cent of the total. The decrease for the year in Grant County was 4,434,260 pounds, there being a decrease of 4,653,121 pounds in the Central district, an increase of 2,525,689 pounds in the Burro Mountain district, and a decrease of 2,046,960 pounds in the Lordsburg district. The yield from Otero County decreased 550,319 pounds; that from Santa Fe County, 179,297 pounds; and that from Socorro County, 2,114,030 pounds.

Copper ores, chiefly from Grant, Otero, Santa Fe, Socorro, and Torrance counties, yielded 97,101,342 pounds, or nearly 99 per cent of the total; dry and siliceous gold and silver ore (chiefly from the dry ore of Otero County and from the siliceous ore of Lordsburg district, Grant County), yielded 508,438 pounds, or less than 1 per cent; lead ores, chiefly from the Magdalena district, Socorro County, yielded 120,714 pounds; and copper-lead ores, chiefly from the Central district, Grant County, yielded 533,259 pounds.

LEAD.

In 1918 the production of lead amounted to 8,398,239 pounds, valued at $596,275, a decrease of 710,565 pounds in quantity, and of $187,082 in value.

The principal lead-producing districts were the Central district, Grant County, the Magdalena district, Socorro County, the Cooks Peak and Victorio districts, Luna County. Grant County yielded 3,158,493 pounds; Socorro County, 3,078,380 pounds; Dona Ana County, 1,616,479 pounds; and Luna County, 490,493 pounds. Lead ores produced 6,196,976 pounds; lead-zinc ores, 1,137,695 pounds; and copper-lead ores, 934,448 pounds, the combined content of these classes of ores representing 98 per cent of the total.

ZINC.

The total recoverable zinc, whether marketed as metal or as oxide from crude ore and concentrates, shipped from New Mexico in 1918 and calculated in terms of metal and zinc in the various forms of zinc oxide, was 24,050,324 pounds, valued (in terms of the Survey's average price of zinc for the year) at $2,188,579.

Mines producing zinc in New Mexico in 1918 were at Kelly, Socorro County; in the Central and Pinos Altos districts, Grant County; in the Cooks Peak district, Luna County; in the Cerrillos district, Santa Fe County; and in the Organ Mountains district, Dona Ana County.

Zinc ore and concentrates marketed in New Mexico, 1917–18, and average assay of zinc.

Year.	Quantity.	Average assay.
	Short tons.	*Per cent.*
1917	62,573	29.16
1918	48,935	32.84
Decrease	13,638	....

OUTPUT OF ORE AND METAL CONTENT.

Ore and metals produced in New Mexico in 1918.

Source.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Copper ore	4,516,407	11,698.51	251,329	97,101,342	124,423	....
Dry ore	87,214	20,621.04	377,855	508,438	1,865	....
Lead ore	17,945	459.44	116,473	120,714	6,196,976	....
Lead-copper ore	4,072	96.20	36,317	533,259	934,448	....
Zinc ore	110,213	4.00	426	810	2,832	19,554,430
Lead-zinc ore	13,933	....	....	....	1,137,695	4,495,894
	4,749,784	32,879.19	782,400	98,264,563	8,398,239	24,050,324
Placers	....	150.83	21	....	....	....
	4,749,784	33,030.02	782,421	98,264,563	8,398,239	24,050,324

PLACER OUTPUT.

Placer output in New Mexico in 1918.

County.	Gold.		Silver.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		
Colfax	103.18	$2,133	11	$11	$2,144
Grant	32.51	672	9	9	681
Santa Fe	15.14	313	1	1	314
Total, 1918	150.83	3,118	21	21	3,139
Total, 1917	589.16	12,179	92	76	12,255
Decrease, 1918	438.33	9,061	71	55	9,116

CONTENT OF ORES.

Content of copper ores sold or treated in New Mexico in 1918.

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Colfax and Lincoln	39	0.20	10	6,138	....
Dona Ana	705	1.98	2,802	87,186	930
Grant	4,500,817	11,357.94	220,033	96,020,852	103,012
Otero	2,492	174.02	1,162	150,410	....
Sandoval	6	....	118	10,935	....
Santa Fe	3,649	160.89	4,752	220,259	....
Sierra	149	....	36	30,473	....
Socorro	7,893	1.30	21,906	494,170	20,481
Taos	20	2.18	149	2,162	....
Torrance	637	....	361	78,757	....
	4,516,407	11,698.51	251,329	97,101,342	124,423

Content of dry and siliceous gold and silver ores sold or treated in New Mexico in 1918.

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Colfax and Lincoln	13,705	13,164.58	2,036	331	....
Grant	12,721	1,562.62	55,316	393,018	1,583
Otero	3,778	72.50	980	114,007	....
Santa Fe	....	2.29	1	....	....
Sierra	495	27.08	16,377	....	....
Socorro	56,515	5,791.97	303,145	1,082	282
	87,214	20,621.04	377,855	508,438	1,865

Content of lead ores sold or treated in New Mexico in 1918.

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Dona Ana	5,016	3.29	42,859	23,490	1,579,549
Grant	4,591	16.70	32,411	19,314	2,162,147
Luna	1,924	397.15	15,763	....	486,451
Santa Fe	94	29.40	490	587	17,479
Sierra	8	.40	154	....	2,909
Socorro	6,312	12.50	24,796	77,323	1,948,441
	17,945	459.44	116,473	120,714	6,196,976

Content of zinc ores sold or treated in New Mexico in 1918.

County.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounce.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Grant	80,555	4	156	....	1,752	11,864,329
Luna	941	....	....	....	....	463,445
Santa Fe	52	....	....	....	....	16,617
Socorro	28,665	....	270	810	1,080	7,210,039
	110,213	4	426	810	2,832	19,554,430

Content of lead-zinc ores sold or treated in New Mexico in 1918.

County.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fineounces.*	*Fineounces*	*Pounds.*	*Pounds.*	*Pounds.*
Dona Ana	355	....	....	....	36,000	114,000
Grant	42	....	....	....	9,240	12,099
Santa Fe	120	....	....	....	11,000	77,955
Socorro	13,416	....	....	....	1,081,455	4,291,840
	13,933	....	....	....	1,137,695	4,495,894

Content of lead-copper ores sold or treated in New Mexico in 1918.

County.	Ore.	Gold.	Silver	Copper.	Lead.
	Short tons.	*Fine ounce.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Grant	3,732	90.00	30,908	506,197	880,759
Luna	45	.20	679	3,150	4,042
Sierra	149	....	1,969	11,580	23,006
Socorro	146	6.00	2,761	12,332	26,641
	4,072	96.20	36,317	533,259	934,448

SMELTERS.

In New Mexico in 1918 there was one copper smelter in operation for only part of the year, the Santa Fe Gold & Copper Co.'s 125-ton matting furnace at San Pedro, operating on ores from its own mines and some pyrite ore from Leadville, Colo. The lead smelter at Deming, operated in 1917 until destroyed by fire in October, was not rebuilt. The zinc oxide plant at Cerrillos, built in 1917, was operated on zinc carbonate ores from New Mexico, Arizona, and Mexico.

The bulk of the copper ore and concentrates continued to be shipped to the smelter at El Paso. The lead ores which had been diverted in 1916 and 1917 to Pueblo, Colo., were again sent to El Paso, although some lead ores and even copper ores were sent to Pueblo. Copper ores, siliceous ores, and iron ores were shipped to the Copper Queen smelter, at Douglas, Ariz., to the Calumet smelter, at Douglas, Ariz., and to the smelter at Sasco, Ariz. Zinc ore and concentrates were shipped to smelters and zinc oxide plants in Arkansas, Colorado, Kansas, Oklahoma, and the Eastern States.

MINING INDUSTRY.

The gross value of the production of gold, silver, copper, lead, and zinc in New Mexico reached its apex in 1917 with a total value of $34,896,936. In 1918, the gross value of $28,521,413 was also below the $30,827,767 recorded for 1916, to which the gross value of $19,279,468 in 1915 had risen.

Since 1915 the yield of gold and silver has been steadily decreasing, while copper and lead were increasing enormously and zinc was fluctuating but nevertheless maintaining a large production.

The decrease in gold is due to the decreasing production of the Mogollon district, which has slowly brought the yield of gold in New Mexico down, notwithstanding the extraordinary revival of the Aztec mine, at Baldy. The Whiteoaks gold district has been a consistent yearly producer, but the output does not equal that of former years. The reopening of operations at the Hopeful mine and the Vera Cruz mine in the Nogal district will, if operations are continued, help to maintain the output of gold. There is a very small content of gold in the copper concentrates of the Chino Copper Co., but 35 per cent of the gold production of the State in 1918 came from the copper ores of the Burro Mountain, Central, Lordsburg, Orogrande, and San Pedro districts. The San Pedro smelter was operated in 1918 for six months, but is said to have been permanently abandoned, and the Burro Mountain mill, after a successful year in 1918, was temporarily closed early in 1919, but the Lordsburg district, with a decreased output for 1918, has continued a steady production in 1919.

The Mogollon district, which until 1918 had long produced more than 50 per cent of the silver output of the State, produced only 39 per cent of the State total in 1918, and the copper ores of the State in 1918 furnished only 32 per cent of the silver in 1918 and the lead ores only 15 per cent.

The Mogollon Mines Co.'s mill operations at Mogollon were seriously handicapped during the later part of 1918 both by shortage of water and by the effects of the epidemic of influenza. The rebuilding of the Socorro Mining & Milling Co.'s mill, partly destroyed by fire in 1917, was not completed until August, 1918, and the plant was operated irregularly the remainder of the year. In 1919 this company was placed in the hands of a receiver. There are plans being made to reopen the silver district at Bland, Sandoval County.

In 1918 the quantity of ore mined and treated at the Chino Copper Co.'s plants exceeded that for 1917 by 230,000 tons, but the production of copper decreased 4,000,000 pounds, equivalent to 5 per cent, owing to a decrease in mill recoveries mainly because of the necessity of mining for considerable periods from areas where the ores contain large percentages of carbonates and other oxidized copper minerals not recoverable in high percentage by the concentrating methods regularly employed. During the first half of 1919 the Chino Copper Co.'s production was only 28 per cent of the 1918 production, and the company hopes to continue at 50 per cent capacity. The Burro Mountain mill suspended operations in June, 1919. The San Pedro smelter was closed in 1918.

The Organ Mountains district made an increased output of copper in 1918, but the two large companies which have held part of the district under lease and bond have given up their options. The Orogrande district's production of copper fell off heavily during the latter half of 1918.

The lead ores of Magdalena are dependent on the mining of zinc ores, which was curtailed during the last quarter of 1918 and the first half of 1919. The Organ Mountains district made a greatly increased output of lead in 1918, but the principal lessee has abandoned work there. The Cooks Peak lead ores are also dependent on the mining for zinc ores, and there was decided decrease in 1918 for both lead and zinc in this district. Other important lead-producing districts are the Victorio district, from which there was a considerable quantity shipped in 1917 and 1918, and the Central district, from which there was an increased production of lead in 1918.

The shipments of zinc carbonate in 1918 were much less than in 1917, there being a decided decrease in shipments in 1918 of this class of ore from the important zinc carbonate district at Kelly, and no ore shipped from the Tres Hermanas and Florida Mountains districts, from both of which appreciable quantities were shipped in 1917. The Graphic flotation mill at Kelly was idle the last three months of 1918, and the Kelly magnetic mill was idle the whole year. The Cleveland magnetic separation mill at Pinos Altos was active the first half of 1918, but was operated at greatly reduced capacity during the latter half of the year and was finally closed. The Hanover concentration mill was operated steadily in 1918 but closed in the spring of 1919.

Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1918.

County.	Number of mines producing.	Ore.	Gold.[a]		Silver.[a]	
			Quantity.	Value.	Quantity.	Value.
		Short tons.	*Fine ozs.*		*Fine ozs.*	
Colfax and Lincoln [b]	12	13,744	13,267.96	$274,273	2,057	$2,057
Dona Ana	4	6,076	5.27	109	45,661	45,661
Grant	52	4,602,458	13,063.77	270,052	338,833	338,833
Luna	9	2,910	397.35	8,214	16,442	16,442
Otero	9	6,270	246.52	5,096	2,142	2,142
Sandoval	1	6	....	....	118	118
Santa Fe	7	3,915	207.72	4,294	5,244	5,244
Sierra	10	801	27.48	568	18,536	18,536
Socorro	16	112,947	5,811.77	120,140	352,878	352,878
Taos	1	20	2.18	45	149	149
Torrance	7	637	....	....	361	361
Total, 1918	128	4,749,784	33,030.02	682,791	782,421	782,421
Total, 1917	192	4,576,827	51,478.64	1,064,158	1,394,365	1,148,957
Increase or decrease, 1918	−64	+172,957	−18,448.62	−381,367	−611,944	−366,536

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Colfax and Lincoln [b]	6,469	$1,598	....	....	....	....	$277,928
Dona Ana	110,676	27,337	1,616,479	$114,770	114,000	$10,374	198,251
Grant	96,939,381	23,944,027	3,158,493	224,253	11,876,428	1,080,755	25,857,920
Luna	3,150	778	490,493	34,825	463,445	42,173	102,432
Otero	264,417	65,311	....	....	....	....	72,549
Sandoval	10,935	2,701	....	....	....	....	2,819
Santa Fe	220,846	54,549	28,479	2,022	94,572	8,606	74,715
Sierra	42,053	10,387	25,915	1,840	....	....	31,331
Socorro	585,717	144,672	3,078,380	218,565	11,501,879	1,046,671	1,882,926
Taos	2,162	534	....	....	....	....	728
Torrance	78,757	19,453	....	....	....	....	19,814
Total, 1918	98,264,563	24,271,347	8,398,239	596,275	24,050,324	2,188,579	28,521,413
Total, 1917	105,568,000	28,820,064	9,108,804	783,357	30,200,000	3,080,400	34,896,936
Increase or decrease, 1918	−7,303,437	−4,548,717	−710,565	−187,082	−6,149,676	−891,821	−6,375,523

[a] Includes placer production.

[b] In order to avoid disclosing individual figures, the production of Colfax and Lincoln counties is combined.

Gold and silver produced at mills in New Mexico, 1909–1918.

Year.	Ore to gold and silver mills.	Gold in bullion.	Silver in bullion.	Ore to concentrating mills.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
1909	32,830	6,725.84	169,650	78,782
1910	67,148	14,220.94	412,272	61,379
1911	109,113	21,894.14	771,914	59,622
1912	106,208	20,342.58	842,018	1,142,002
1913	124,536	24,891.37	1,024,363	1,987,896
1914	156,913	29,730.64	1,161,455	1,955,881
1915	149,650	40,474.37	1,129,701	2,428,344
1916	135,267	34,332.33	841,865	3,442,681
1917	123,824	26,270.55	657,437	4,215,988
1918	70,179	17,081.09	264,070	4,551,983
Increase or decrease, 1918	−53,645	−9,189.46	−393,367	+335,995

Mine production of metals from New Mexico concentrates, 1909–1918.

Year.	Concentrates produced.					
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1909	7,554	1,598.31	112,639	2,015,118	436,558	821.766
1910	18,298	4,536.03	255,060	1,050,238	2,701,843	6,882,175
1911	16,243	7,938.70	333,654	1,125,927	1,562,768	5,304,000
1912	81,811	7,190.63	290,081	28,760,908	1,984,435	6,404,768
1913	198,243	7,913.39	294,948	51,723,923	1,076,848	8,594,183
1914	161,003	12,754.17	312,734	53,398,611	637	8,541,261
1915	174,074	12,876.72	323,402	66,326,554	75,580	11,179,266
1916	311,726	13,125.69	336,472	80,235,404	727,888	16,625,663
1917	360,614	10,167.96	196,713	92,990,700	2,108,154	21,130,965
1918	353,761	11,910.21	210,026	92,609,319	52,374	12,480,507
Increase or decrease 1918	−6,853	+1,742.25	+13,313	−381,381	−2,055,780	−8,650,458

Mine production of metal from New Mexico crude ore shipped to smelters, 1909–1918.

By years.

Year.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1909	52,544	2,196.50	115,332	3,378,028	4,593,209	12,264,179
1910	63,338	3,317.99	176,281	3,564,148	1,618,998	11,205,954
1911	63,964	6,162.71	249,710	2,931,113	1,403,454	4,933,176
1912	104,076	9,595.57	404,462	5,270,056	3,509,583	7,161,869
1913	105,228	9,478.13	311,872	4,584,783	2,869,516	7,928,978
1914	120,059	12,785.76	302,926	5,909,314	1,763,004	9,862,131
1915	219,078	16,882.78	552,373	10,461,812	4,466,781	14,224,798
1916	293,002	18,881.71	587,865	12,514,885	7,486,301	19,944,986
1917	237,015	14,450.93	540,123	12,577,300	7,000,650	9,069,035
1918	127,622	3,887.89	308,304	5,655,244	8,345,865	11,569,817
Increase or decrease, 1918	−109,393	−10,563.04	−231,819	−6,922,056	+1,345,215	+2,500,782

By kind of ores (in 1918).

Dry and siliceous	17,035	1,650.16	72,797	507,872	1,583	....
Copper	61,247	1,678.09	82,432	4,492,589	116,894	....
Lead	17,745	459.44	116,332	120,714	6,152,413	....
Zinc	13,590	4.00	426	810	2,832	7,073,923
Copper-lead	4,072	96.20	36,317	533,259	934,448	....
Zinc-lead	13,933	....	....	....	1,137,695	4,495,894

Mine production of metals from New Mexico crude ore and concentrates combined shipped to smelter, 1909–1918.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1909	60,098	3,794.81	227,971	5,393,146	5,029,767	13,085,945
1910	81,636	7,854.02	431,341	4,614,386	4,320,841	18,088,129
1911	80,207	14,101.41	583,364	4,057,040	2,906,222	10,237,176
1912	185,887	16,786.20	694,543	34,030,964	5,494,018	13,566,637
1913	303,471	17,391.52	606,820	56,308,706	3,946,364	16,523,161
1914	281,062	25,539.93	615,660	59,307,925	1,763,641	18,403,392
1915	393,152	29,759.51	875,775	76,788,366	4,542,361	25,404,064
1916	604,728	32,007.40	924,337	92,747,289	8,214,189	36,570,649
1917	597,629	24,618.89	736,836	105,568,000	9,108,804	30,200,000
1918	481,383	15,798.10	518,330	98,264,563	8,398,239	24,050,324
Decrease, 1918	116,246	8,820.79	218,506	7,303,437	710,565	6,149,676

Mine production of metals from New Mexico crude ore shipped to smelters, 1918.

County.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Colfax	23	0.20	4	4,288	....	....
Dona Ana	6,076	5.27	45,661	110,676	1,616,479	114,000
Grant	71,924	2,997.80	169,808	4,330,628	3,150,964	3,173,713
Lincoln	16	....	6	1,850	....	....
Luna	2,910	397.35	16,442	3,150	490,493	463,445
Otero	6,270	246.52	2,142	264,417	....	....
Sandoval	6	....	118	10,935	....	....
Santa Fe	3,915	190.29	5,242	220,846	28,479	94,572
Sierra	801	27.48	18,536	42,053	25,915	....
Socorro	35,024	20.80	49,835	585,482	3,033,535	7,724,087
Taos	20	2.18	149	2,162	....	....
Torrance	637	....	361	78,757	....	....
	127,622	3,887.89	308,304	5,655,244	8,345,865	11,569,817

Gold and silver contained in bullion produced at mills in New Mexico, 1918.

Process.	Ore.	Gold in bullion.	Silver in bullion.
	Short tons.	*Fine ounces.*	*Fine ounces.*
Amalgamation	13,727	12,116.71	1,956
Cyanidation	56,452	4,964.38	262,114
	70,179	17,081.09	264,070

The quicksilver consumed in New Mexico in 1918 amounted to 279 pounds, representing 1 pound for every 43 ounces of gold, and the sodium cyanide to 79,065 pounds, representing 1 pound for every 0.06 ounce of gold and 1 pound for every 3.32 ounces of silver.

REDUCTION MILLS.

Mineral Resources for 1912, Part I, pp. 832–835, contained a complete list of the reduction mills in New Mexico in 1912 and descriptions of equipment and process. Changes in this list for 1913–1918 have been noted in the text for the several counties for each year, and reference should be made to the report for 1912 for details of equipment.

REVIEW BY COUNTIES.[1]

BERNALILLO COUNTY.

Assessment and development work only was done in the Coyote, Hell Canyon, and Soda Springs districts.

COLFAX COUNTY.

Elizabethtown district (including Baldy).—The Aztec mine[2] at Baldy was operated the entire year, shipping gold bullion and concentrates carrying a high content of gold from the 10-stamp amalgamation-concentration mill on the property. Several placer mines were operated during the year at Elizabethtown. The following table shows the production of Elizabethtown and Baldy districts (which is the output for Colfax County) from 1904 to 1916, inclusive:

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[1] For discussion of geology of the districts mentioned in the following pages the reader is referred to Hill, J. M., The mining districts of the Western United States: U. S. Geol. Survey Bull. 507, 1912; and Lindgren, Waldemar, The ore deposits of New Mexico: U. S. Geol. Survey Prof. Paper 68, 1910.

[2] Lee, W. T., The Aztec gold mine, Baldy, N. Mex.: U. S. Geol. Survey Bull. 620, pp. 325–330, 1916.

Mine production in Elizabethtown district, Colfax County, N. Mex., 1904–1918.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	380	$90,639	$3,638	67	....	....	$94,316
1905	13	31,994	445	157	....	....	31,749
1906	....	14,492	....	93	....	....	14,554
1907	....	11,914	....	83	....	....	11,969
1908	....	11,274	....	66	....	....	11,309
1909	83	16,037	1,705	127	....	....	17,808
1910	93	9,588	3,433	261	....	2,182	13,258
1911	2,306	9,860	31,547	1,254	5,587	....	42,770
1912	3,025	8,385	27,316	634	6,243	....	37,121
1913	3,222	4,550	15,588	254	1,147	134	20,475
1914	2,860	4,930	63,129	577	11,083	154	69,858
1915	2,673	2,631	350,745	2,483	14,092	787	357,138
1916	6,064	5,039	417,258	2,803	447	....	424,251
1917 and 1918	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a Combined with Lincoln County.

DONA ANA COUNTY.

Mine production in Dona Ana County, N. Mex., 1904–1918.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	5,580	....	24,101	40,000	1,581,488	....	$87,145
1905	6,566	$6,710	21,776	96,058	327,707	30,000	52,020
1906	16,220	....	34,051	434,000	1,207,193	....	175,386
1907	6,084	6	25,612	776,125	675,189	....	207,920
1908	3,090	....	9,283	21,150	379,697	....	23,660
1909	2,816	248	16,975	10,600	772,023	....	43,650
1910	2	....	15	....	705	....	39
1911	5	....	111	363	1,561	....	173
1912	78	17	1,790	6,685	26,129	....	3,397
1913	155	30	1,232	10,189	9,557	....	2,774
1914	451	927	3,564	78,180	29,897	....	14,462
1915	1,599	2,426	8,335	241,749	19,170	....	49,859
1916	2,615	503	7,948	206,187	34,696	106,679	73,144
1917	417	98	4,705	16,121	162,965	....	22,391
1918	6,076	109	45,661	110,676	1,616,479	114,000	198,251
Increase, 1918	5,659	11	40,956	94,555	1,453,514	114,000	175,860

Organ Mountains district.—Oxidized lead ores were shipped from the Stephenson-Bennett group, Organ Mountains district, to the El Paso smelter. This ore carried a small quantity of wulfenite, the molybdenum content of which was not paid for by the smelter. Oxidized lead ores carrying a higher content of wulfenite were shipped to the El Paso Concentrating Works, from which concentrates were sold for the molybdenum content only. Other producing mines were the Memphis and the Torpedo group.

GRANT COUNTY.

Mine production in Grant County, N. Mex., 1904–1918.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
		Placer.	Deep.					
	Short tons.			*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	47,032	$8,081	$60,347	74,793	4,428,508	179,142	....	$695,099
1905	81,160	10,943	35,064	86,629	5,291,222	321,035	257,203	954,026
1906	127,800	2,290	97,519	163,987	6,388,830	710,895	144,656	1,492,069
1907	146,746	3,782	109,260	224,279	8,046,315	1,394,390	73,729	1,948,582
1908	75,254	3,514	42,168	95,477	5,242,767	244,589	251,070	810,403
1909	89,576	3,584	34,242	74,198	5,176,585	215,070	203,278	760,590
1910	70,862	2,641	63,291	156,557	4,404,394	257,953	1,285,500	790,598
1911	93,770	4,043	112,241	221,882	8,918,928	694,247	306,895	772,481
1912	1,200,691	2,551	163,645	356,057	32,952,133	2,309,732	3,135,000	6,142,526
1913	1,984,304	1,646	102,971	206,215	53,436,177	446,805	2,553,322	8,674,423
1914	1,986,921	21,560	319,300	304,679	58,259,113	570,513	3,734,768	8,448,810
1915	2,523,275	1,979	363,104	508,552	72,487,200	2,251,383	6,083,580	14,168,358
1916	3,577,868	2,009	417,666	549,907	87,784,545	2,561,638	14,084,843	24,440,634
1917	4,315,341	3,153	401,293	487,558	101,373,641	3,224,477	13,335,127	30,118,686
1918	4,602,458	672	269,380	[a] 338,833	96,939,381	3,158,493	11,876,428	25,857,920
Increase or decrease, 1918	+287,117	−2,481	−131,913	−148,725	−4,434,260	−65,984	−1,458,699	−4,260,766

[a] Includes 9 ounces of placer silver.

Apache No. 2 (Anderson) district.[1].—A reduced quantity of silver-copper ore was shipped from the Apache mine in Apache No. 2 district.

Black Hawk district.—A car of copper-silver ore was shipped from the Black Hawk mine.

Burro Mountain district.[2]—The annual report (dated February 1, 1919) of the Phelps Dodge Corporation for 1918 says of the Burro Mountain Branch mines and 1,500-ton gravity and flotation-concentration mill:

> The net production of copper and silver, based on smelter returns, from shipments of concentrates, precipitates, and lease ore, was as follows:
>
> | | Dry tons. | Copper. | | Silver. |
> |---|---|---|---|---|
> | | | *Per cent.* | *Pounds.* | *Ounces.* |
> | Concentrates | 53,146 | 14.875 | 15,178,760 | 43,150 |
> | Precipitates | 8 | 62.890 | 9,859 | .... |
> | | 53,154 | .... | 15,188,619 | 43,150 |
> | Lease ore | 24,824 | 4.239 | 2,104,647 | .... |
> | | 77,978 | .... | 17,293,266 | 43,150 |
>
> The copper production exceeded that of the previous year by over 3,000,000 pounds. There were mined for delivery to the concentrator 582,981 tons, having an assay value of 1.928 per cent copper.

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[1] As distinguished from Apache (Chloride) district, Sierra County.

[2] Paige, Sidney, Metalliferous ore deposits near the Burro Mountains, Grant County, N. Mex.: U. S. Geol. Survey Bull. 470, pp. 131–150, 1911; U. S. Geol. Survey Geol. Atlas, Silver City folio (No. 199), 1916.
Weed, W. H., The copper mines of the United States in 1905: U. S. Geol. Survey Bull. 285, p. 118, 1906.
Somers, R. E., Geology of the Burro Mountains: Am. Inst. Min. Eng. Bull. 101, pp. 957–996, 1915.
Bush, F. V., Burro Mountain porphyry copper developments: Min. and Sci. Press, Feb. 6, 1915, pp. 222–224.

The cost of mining a ton of ore shows a very satisfactory reduction, while the grade of ore mined dropped only slightly. This reduced mining cost, in the face of recent increased labor and supply charges, may be attributed, in part, to the better condition of the stopes and to increased drawing from the broken ore reserves in the shrinkage stopes.

Although there was a decrease of 7,519 feet in the amount of development work accomplished, the ore reserves were increased by 235,000 tons. Stope preparation work was carried on vigorously, and several new stopes were brought into the producing class. The accumulation of broken ore in the shrinkage stopes, on the other hand, was decreased by 82,000 tons during the year.

The estimated tonnage of the Bison ore body has been increased 164,000 tons, but the oxide content of this ore body is high.

The most important development of the year has been the greatly increased tonnage developed in the Michigan vein. While the grade of this ore is not high, its low oxide content should make it amenable to high extraction.

The employment of caving operations and the still cheaper drawing off of the already broken ore in shrinkage stopes made possible a constant lowering of the stoping costs per ton up to May. It resulted, however, in considerable dilution, and toward the closing months of the year it became necessary to reduce the amount of caving tonnage and increase the amount of top-slice work so as to improve the grade of ore. The stoping efficiency throughout the year was excellent.

Preparations are nearly completed for a new pump on the sixth level of No. 2 shaft, and also a new pump at the collar of this shaft. Underground a new traction type elevator hoist has been installed, and a new 4-ton storage battery locomotive ordered. At No. 3 shaft a loading pocket is being constructed to do away with the present belt conveyor and loading system which has been expensive to operate and maintain.

The results of the concentrator operations for the year are shown below:

Ore milled, 585,083 tons,[1] assaying 1.928 per cent copper.
Moisture of general heads, 3.094 per cent.
Copper in ore milled, 11,283.295 tons.
Concentrates produced, 53,146 tons,[1] assaying 14.875 per cent copper.
Tailings produced, 531,937 tons,[1] assaying 0.630 per cent copper.
Saving (average of four methods of figuring), 70.232 per cent.
Yield, 1.351 per cent.
Ratio of concentration, 11.009.
Ore milled per day, actual running time, 1,709.519 tons.
Fresh water used per ton of ore milled, 736.514 gallons.
Kilowatt hours per ton of ore milled, 10.159.

The average assay of the general heads dropped from 1.972 per cent copper to 1.928 per cent, and with this there was an increase in the proportion of oxide copper, which brought the net sulphide content down to 1.651 per cent, as against 1.784 per cent for 1917. This lower grade and more advanced oxidation of the ore account largely for the drop in mill extraction from 72.301 per cent to 70.065 per cent. The sulphide content of the tailings was 0.441 per cent, or 0.017 per cent less than in the previous year.

The replacement of the old single-unit flotation machines by 3-unit machines has improved the recovery in the flotation department. Extensive experimental work carried on during the year has demonstrated that better metallurgical results can be obtained by some changes from the present flow sheet, the most important of which are fine grinding in closed circuit, the addition of more and improved flotation units, and additional tables below flotation. Definite plans, based on this experimental work, are in course of preparation.

Churn-drill operations were continued at a reduced rate throughout the year. The greater part of the work was confined to prospecting the property of the Azure Mining Co., which is held under option. No important discoveries of ore were made in either the Azure or the company ground.

Twenty-three holes were sunk to an average depth of 488.5 feet, making a total of 11,237 feet drilled, as compared with 30.542 feet for 1917.

The leaching beds at the mine were kept under irrigation intermittently during the year, and according to water measurements and assays 8.9 per cent of the total copper in the heaps was recovered, making the total extraction for two years 33.8 per cent. As an experiment the plant has furnished valuable information as to the possibilities of the process and has accentuated the problems which must be met by the new experimental plant now under construction.

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[1] Dry weight.

A car of copper-silver ore was shipped from the Austin-Amazon group. The Phelps Dodge Corporation also prospected with churn drills several adjoining areas, principally that of the Azure Mining Co.

Central district.[1]—The output of the Central district, embracing the towns of Bayard, Fierro, Georgetown, Hanover, and Santa Rita was 3,908,816 tons of ore, yielding $128,577 in gold, 111,175 ounces of silver, 77,547,300 pounds of copper, 2,857,887 pounds of lead, and 8,826,967 pounds of zinc, with a total value of $20,400,099. This district is the most important producing district in New Mexico. Besides the Chino Copper Co.'s mines, at Santa Rita, and the Empire Zinc Co.'s mines, at Hanover, there were 16 other producing mines in the district. From the Hanover and Modoc mines was shipped several cars of copper ore to the Copper Queen smelter, at Douglas, Ariz. Zinc carbonate ore was shipped from the Hanover mines of the Empire Zinc Co., and from the Hanover Copper Co.'s group. A large quantity of zinc sulphide ore was shipped from the Welch mine by the Republic Mining & Milling Co., whose second annual public report[2] for the year ending December 31, 1918, says in part:

> From the Welch mine the Republic Mining & Milling Co. shipped 2,925 tons of zinc sulphide ore, with a value of $108,868, against which was an operating expense of mining, hauling to railroad, and other expenditures of $41.250, and freight on ore of $15,706, a total operating expense of $56,956, leaving a net income of $51,912.
>
> The total work done on your property beginning October 1, 1916, and ending December 31, 1918, was:

	1917	1918	Total.
	Feet.	*Feet.*	*Feet.*
Shafts	207	127	334
Drifts	763	359	1,122
Raises	None.	130	130
	970	616	1,586

> No work was done in the drift to the northeast on the 100-foot level of the No. 1 shaft. The face of this drift is now in a body of magnetic iron oxide, assaying 54 per cent iron, 2 per cent zinc, and 3.4 per cent sulphur. This body of magnetic iron crops on the surface for a distance of 700 feet and has a width varying from 50 to 75 feet. No effort was made to ship iron from the cropping in 1918. While this body of iron ore is not fully developed, there are 500,000 tons indicated, one-half of which should be a marketable ore assaying 58 to 62 per cent iron. * * *
>
> In the previous annual report it was stated that a sulphide ore body was just being entered at the close of the year 1917, at a point 150 feet south of the No. 1 shaft on the 150-foot level. Nearly all the work done by your company in 1916 was done in extracting ore from this body.
>
> At the end of 1918 this ore body had been opened with drifts, raises, and crosscuts to the extent of 185 feet in length, 50 feet in width, and 35 feet in thickness. Using the above dimensions, the ore actually blocked out in this

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[1] Paige, Sidney, U. S. Geol. Survey Geol. Atlas, Silver City folio (No. 199), 1916; The Hanover iron-ore deposits, New Mexico: U. S. Geol. Survey Bull. 380, pp. 199–214, 1909. Birkinbine, John, Iron ores of the United States: U. S. Geol. Survey Eighteenth Ann. Rept., pt. 5, pp. 48–50, 1897.

[2] Salt Lake Min. Rev., July 30, 1919, pp. 27–28.

body at the end of the year was 35,000 tons with 60,000 tons indicated. * * * The general average of the whole ore body is 35 per cent zinc. A system of screening and sorting has been devised whereby about 30 per cent of the total ore extracted can be shipped direct to the smelter. During 1918, about 3,000 tons were shipped and smelter returns show 44 per cent zinc content. About 4,000 tons are blocked out which can be shipped. During the year 1918 there were about 5,000 tons of mill ore placed on the dump, making a total of dump ore which has no value to your company until milled.

In the last annual report it was stated that your company had 75,000 tons of indicated ore. At the end of 1918 we estimate 44,000 tons blocked out in the mine assaying 20 per cent zinc and 6,000 tons on the dump, assaying 20 per cent zinc, making 50,000 tons total ore assaying 20 per cent zinc.

Both oxidized and sulphide copper ore was shipped from the Dewey and Schley mines, copper ore from the Copper Rose, Philadelphia, and San Jose mines, copper and lead-copper ore from the Groundhog and the Ivanhoe, and lead oxidized ore of a good grade from the Lucky Bill mine.

The Empire Zinc Co. also operated continuously its separating mill[1] at Hanover on zinc sulphide ores from its mines.

The Hanover Bessemer Iron & Copper Co. operated its electrostatic separation mill for the treatment of iron ores the entire year, with the resulting recovery of a very large quantity of copper products as well, which carried also some gold and silver.

The Chino Copper Co. is mining a low-grade copper deposit at Santa Rita by steam shovels. The ore is concentrated at Hurley, where the company's 7-section wet-concentration and flotation mill is located. Concentrates are shipped principally to El Paso.

The ninth annual report of the Chino Copper Co., dated March 7, 1919, covering the year ended December 31, 1918, states:

In the latter part of the year a property (Hermosa Copper Co.) was purchased which consisted of 46 patented mining claims of an area of 643 acres, together with a considerable amount of machinery equipment. Of this total acreage 35 claims, covering an area of 478 acres, are in one body adjoining the Chino Co.'s main group of patented mining claims. This area is valuable to the company for the extension of the waste dumps, aside from any mineral contents that may be found. In the past some commercial ores have been extracted from various portions of this new property and a part of it offers good possibilities for the development of ore bodies of considerable value.

The company now has 206 mining claims, covering a total of 3,493 acres, of which 177 claims, covering an area of 3,055 acres, are patented, while 29 claims are unpatented and comprise an area of 438 acres. Of the total area of mining claims owned, 3,328 acres lie in one contiguous body. In addition to the area above stated, the company owns 120 acres of agricultural land adjacent to the group of mining claims, making a total of 3,448 acres of ground owned and controlled at or near Santa Rita, lying in one body, the total area owned and controlled in the Central mining district being 3,613 acres. Forty acres of the agricultural tract were disposed of during the year, though the mineral rights were retained.

During 1918 information was received from the State Land Office showing that 40 acres of land applied for purchase from the State had not been allowed by the United States Land Office. This 40-acre tract is not absolutely essential at the present time. At the close of the year the total area owned and controlled by the company in connection with its mill location at Hurley, and its various water rights and tailings-disposal system, contains 40 acres less, or 18,530 acres. Of this total area, 17,250 acres are patented, 40 acres are in process of patent through scrip filings, and 1,200 acres are covered by applications for purchase from the State of New Mexico.

During the first two months of the year three drills were in operation; the balance of the year only two drills were engaged in development work. These operations were in connection with the South and Southwest ore bodies, extensions of which were demonstrated. The total drilled for the year was 15,020 feet, and since the beginning of operations there has been a total of 264,748 feet drilled.

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[1] For description, see Met. and Chem. Eng., Oct. 10, 1916, pp. 481–482.

A recalculation of the ore reserves as of December 31, 1918, was completed, showing that 95,580,737 tons, averaging 1.63 per cent copper, remained unmined. There remain in the ore stock pile 882,824 tons, averaging 1.86 per cent copper, and a special pile, placed for experimental purposes in the near future, containing 88,465 tons, averaging 1.37 per cent copper. The total ore, therefore, unmined or untreated December 31, 1918, is 96,552,026 tons, averaging 1.63 per cent copper. Since the beginning of operations there have been milled or shipped direct to the smelter 17,976,149 tons. The total ore developed by churn drilling to date is 114,528,175 tons of an average grade of 1.66 per cent copper.

The total ore and waste removed by steam shovels during the year was 5,209,760 cubic yards of material in place. Of this amount, 3,264,556 cubic yards were stripping, the remainder being equivalent to 3,749,238 tons of ore. Of the ore that was removed, 3,621,438 tons were sent to the mill, 101 tons were shipped direct to the smelter, 88,465 tons were placed on an area that had been prepared for heap-leaching experiments, and 39,234 tons were placed on the ore stock pile No. 3, located at a convenient place on lands purchased this year, in order that the low-grade carbonate ores, which we are not yet prepared to treat, can be handled more economically than by switching to old locations. This new location affords better railroad facilities. There remain on the ore stock piles at Santa Rita at the close of the year 882,824 tons.

From the beginning of steam-shovel operations on September 23, 1910, when the first shovel was erected, there has been removed a total of 33,588,108 cubic yards of material in place, of which 23,863,755 cubic yards were stripping, the remainder being equivalant to 18,943,755 tons of ore. Of this ore, 971,289 tons remained stored in the stock piles and in the heap-leach pile at the mine, while 17,948,678 tons were shipped to the mill and 23,788 tons were shipped direct from the steam shovels to the smelter.

Of the ore shipped to the mill during the year, 17.1 per cent came from the Northwest ore body, 23.4 per cent from the North ore body, 48.9 per cent from the South ore body, 4.9 per cent from the Southwest ore body, and 5.7 per cent from the ore pile.

The average cost of steam-shovel operations for the removal of both ore and stripping for the year was 69.55 cents per yard, as against 50.88 cents per yard for the year 1917.

The program that was approved two years ago, covering additions and alterations in the original five sections and an addition of two sections to the mill, and in necessary expenditures in the mechanical department, was continued throughout the year, although hampered in many ways by shortage of labor and delays in receiving material. All of the alterations were completed in sections Nos. 1 and 5 in the early part of the year. Section No. 6 was put in full operation in February and part of section No. 7 in July, 1918. Owing to the fact that certain apparatus was not received until December, and therefore could not be installed, section No. 7, while partially finished, was still uncompleted at the end of this fiscal year, and it was therefore impossible to begin the treating of oxidized ore, as had been planned.

For the year 1918 there was treated in the mill at Hurley a total of 3,836,400 dry tons of ore, equivalent to an average of 10,510 tons per day, this average for the year exceeding that of 1917 by 625 tons per day. The average content of the ore treated for the year was 1.63 per cent copper, or 0.01 per cent lower than for 1917. The total production of concentrates was 278,413 tons, which averaged 14.25 per cent copper. The total amount of copper contained in concentrates was 79,322,795 pounds, corresponding to a recovery of 20.676 pounds per ton of ore, equivalent to an extraction of 63.275 per cent, which was 6.041 per cent lower than for the year 1917. This lower extraction was due to the fact that during the year it was necessary to take a very much increased tonnage of heavily oxidized ores which the mill was not prepared to treat to the best advantage owing, as has previously been stated, to the failure to receive necessary apparatus for the completion of section No. 7.

The average cost of milling was $1.37 per ton, an increase in the cost over 1917 of 33 per cent. Excluding the amounts set up for taxes, which are included in the above figure, the increased cost in milling was only 6.08 per cent, in spite of a very much greater percentage increase in the costs of supplies and labor.

During the year there were shipped from the mine direct to the smelter 101 dry tons of ore, containing 17,577 gross pounds of copper, The production of copper contained in the concentrates and other shipping products for the year, by quarters, was as follows:

First quarter	pounds	20,721,217
Second quarter	do	19,030,992
Third quarter	do	19,449,195
Fourth quarter	do	20,138,968
Total for year 1918	do	79,340,372
Total for year 1917	do	83,339,782

The average cost of net copper produced for the year, after making deductions for smelter allowances and crediting precious metal values and miscellaneous income, was 17.178 cents per pound, as compared with 11.39 cents per pound for 1917. The credit for precious metals amounted to 0.053 cent per pound and that of miscellaneous income to 0.057 cent per pound, a total of 0.11 cent per pound. The per-pound cost stated includes depreciation and reserves for taxes set up during the year.

Items affecting costs for the year were the two increases given to our employees, one in March and the other in July, the latter being a flat increase of 50 cents per day. On June 25 there was a general increase in freight rates put into effect; the increase applying to bullion rates amounted to an advance of 86⅔ per cent, and at the same time it was necessary to modify smelting and refining contracts in order to properly recompense the smelting and refining companies for their additional costs. All of these increased items of expense are reflected in our additional costs for the year; further, a calculation was made, which demonstrated that the deferred stripping charge heretofore used was not sufficient under present costs of labor and supplies to properly liquidate, over the life of the property, this item. It was therefore decided that beginning with July this charge would be increased 50 per cent.

As a result of the foregoing the per-pound costs were increased during the year over 1917, as follows: Labor, 24.82 per cent; supplies, 27.13 per cent; freights, smelting, refining, etc., 29.72 per cent; general administration (exclusive of taxes and depreciation), 13.63 per cent; set-up for taxes, 130.06 per cent; and depreciation, 11.53 per cent; the net increase amounting to 39.14 per cent.

Mine production in Central district, Grant County, N. Mex., 1904–1918.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	21,048	$5,582	282	3,264,208	11,977	....	$430,607
1905	17,115	....	....	2,704,233	....	....	421,860
1906	39,155	4	1,524	3,075,001	235,070	99,656	614,648
1907	57,079	5,659	36,813	4,994,575	855,358	73,729	1,078,555
1908	41,852	777	296	3,994,502	29,122	251,070	541,231
1909	41,456	816	1,380	3,348,808	23,256	203,278	448,856
1910	37,008	....	404	2,679,630	155	1,285,500	409,955
1911	45,584	104	8,673	1,413,189	605,978	290,122	325,156
1912	1,136,290	998	29,586	29,512,812	2,172,676	2,205,824	5,138,779
1913	1,948,471	9,697	12,500	51,695,656	331,440	2,187,266	8,167,144
1914	1,934,020	102,971	42,971	55,222,874	365,079	3,669,513	7,672,759
1915	2,395,795	102,379	73,267	66,581,366	1,542,234	5,628,870	12,561,729
1916	3,134,791	133,962	116,953	74,228,606	2,122,797	7,278,575	19,592,956
1917	3,668,289	138,873	121,386	82,200,421	2,250,337	7,398,853	23,627,822
1918	3,908,816	128,577	111,175	77,547,300	2,857,887	8,826,967	20,400,099
Increase or decrease, 1918.	+240,527	−10,296	−10,211	−4,653,121	+607,550	+1,428,114	−3,227,723

Chloride Flat district (*near Silver City*).—A small quantity of silver ore and a considerable quantity of iron-manganese ores (to steel and chemical plants only) were shipped from the Chloride Flat district during the year.

Eureka district (*including Sylvanite*).—A small quantity of lead and zinc ores were shipped from the Eureka district.

Fremont district.[1]—Several cars of lead-silver ore were shipped from the Eagle group, Fremont district.

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[1] Darton, N. H., Geology and underground water of Luna County, N. Mex.: U. S. Geol. Survey Bull. 618, pp. 106–107, 1916.

Gold Hill district.—The Cline stamp mill yielded a small quantity of gold-silver bullion from the Gold Hill district.

Lordsburg district (including Pyramid and Virginia or Shakespeare districts).—The production from the Lordsburg district showed a decided decrease in 1918. A part of the ore was concentrated before shipping, the remainder being shipped direct to the smelter. The average assay for the district in 1918 was gold 0.1151 ounce and silver 2.785 ounces per ton, and copper 2.013 per cent. The principal producing property was the group operated by the Eighty-Five Mining Co. This company completed a 300-ton gravity and oil flotation mill in 1918 and operated it from June through December. Other producing mines were the Atwood, Bonney, Last Chance, and Nellie Bly.

Mine production in Lordsburg district, Grant County, N. Mex., 1904–1918.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	250	$1,184	2,580	18,200	12,000	$5,582
1905	366	10	7,584	48,000	....	12,079
1906	1,743	5,168	27,261	212,601	....	64,465
1907	5,645	8,761	31,303	463,335	10,522	122,646
1908	7,532	10,617	9,889	259,079	11,363	50,534
1909	10,690	25,983	50,154	589,969	8,862	129,140
1910	29,220	59,798	130,324	1,627,591	19,662	337,742
1911	46,139	106,648	182,448	2,455,336	2,157	510,359
1912	55,340	144,859	275,251	3,155,585	4,562	835,015
1913	31,284	55,234	154,779	1,601,461	14,572	397,588
1914	38,964	101,080	232,647	2,614,674	30,049	578,658
1915	92,093	222,848	374,325	3,890,365	28,723	1,094,795
1916	118,966	267,148	373,074	4,755,179	30,478	1,684,508
1917	99,532	245,607	295,443	4,261,956	41,442	1,656,130
1918	55,015	130,858	153,236	2,214,996	17,831	832,464
Decrease, 1918	44,517	114,749	142,207	2,046,960	23,611	823,666

Pinos Altos district.[1]—Production from the Pinos Altos district in 1918 showed a decided decrease.

The Cleveland zinc mine and its magnetic separating mill were operated steadily from January through July, but at greatly reduced capacity for the remainder of the year. Other producing mines were the Copper Bell, Langston, and Bear Creek.

Mine production in Pinos Altos district, Grant County, N. Mex., 1904–1918.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
		Placer.	Deep.					
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	4,719	$7,750	$49,660	37,229	104,069	2,653	....	$92,587
1905	6,348	10,943	31,442	39,585	103,469	....	160,779	82,442
1906	14,074	2,290	89,674	83,566	328,788	....	....	211,409
1907	14,841	3,782	78,723	65,862	322,195	....	....	190,413
1908	1,451	1,479	8,548	8,941	34,514	3,953	....	21,528
1909	38	3,584	2,083	1,377	6,200	418	....	7,207
1910	20	2,494	1,372	223	269	2,226	....	4,119
1911	355	4,043	1,406	5,616	3,232	4,063	16,773	9,968
1912	6,169	2,551	7,973	15,864	96,507	50,289	929,176	102,581
1913	3,643	1,646	29,162	28,276	100,555	83,067	366,056	87,626
1914	3,686	[a] 21,650	114,181	23,256	129,587	29,994	48,840	169,497
1015	7,024	1,979	31,823	19,856	377,463	130,638	454,710	172,463
1916	46,471	2,009	11,775	17,816	122,716	152,696	6,741,925	967,621
1917	45,993	3,153	7,731	10,803	49,945	80,989	5,556,892	607,189
1918	28,983	672	1,972	2,243	12,227	40,028	3,013,802	284,324
Decrease, 1918	17,010	2,481	5,759	8,560	37,718	40,961	2,543,090	322,865

[a] Placer and surface lode mines combined. Only small quantity recovered by actual placer methods. Fineness so similar, separation not practicable.

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[1] Paige, Sidney, The ore deopsits near Pinos Altos, N. Mex.: U. S. Geol. Survey Bull. 470, pp. 109–125, 1911; U. S. Geol. Survey Geol. Atlas, Silver City folio (No. 199), 1916.

San Simon (*Granite Gap*) (*Steins*) *district.*—Several cars of ore were shipped from the San Simon district in 1918, yielding principally lead, copper, and silver but also some gold and zinc. Producing mines were the Merrimack, Silver Hill, and Hamilton group.

Steeplerock district.—The production from the Steeplerock district was small, the production being from the Carlisle and the Shamrock group.

Swarts (*Carpenter or Camp Monarch*) *district.*—The mill on the property of the old Monarch mines in the Swarts district was remodeled by the installation of a ball mill and two flotation machines and two Wilfley tables, but was operated only a few days owing to shortage of water and low market price for zinc.

Telegraph (*Burro Springs*) *district.*—One car of copper ore was shipped from the Brock mine in the Telegraph district.

GUADALUPE COUNTY.

Mining work seems to have been abandoned in the Pintada district, Guadalupe County.

LINCOLN COUNTY.

Mine production in Lincoln County, N. Mex., 1904–1918.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	820	$20,100	$8,496	2,576	....	2,261	$30,183
1905	3,060	2,260	5,215	757	14,404	7,511	10,532
1906	6,380	....	16,463	1,946	....	....	17,767
1907	5,767	....	41,417	721	....	....	41,893
1908	4,399	816	28,896	5,472	1,195	....	32,770
1909	3,633	472	23,391	388	700	7,977	24,499
1910	10,727	1,400	53,876	559	189	5,614	55,849
1911	1,578	1,629	30,305	184	555	6,620	32,399
1912	2,003	1,008	21,408	1,005	9,988	103,911	29,358
1913	5,589	1,027	41,469	1,100	7,068	94,010	48,392
1914	13,540	908	62,499	961	15,068	10,641	66,360
1915	8,550	1,308	44,068	493	5,091	13,277	47,141
1916	1,490	651	7,093	953	28,045	....	15,270
1917 and 1918	(a)	(a)	(a)	(a)	(a)	(a)	(a)

[a] Combined with Colfax County.

Estey district (*Oscuro Mountains*).—A few tons of copper ore were shipped from prospects in this district.

Jicarilla district.—There was no placer production from this district in 1918.

Nogal (*Bonito Parsons*) *district.*—The 250-ton amalgamation mill completed in 1917 was operated for a part of the year on ores from the Hopeful mine, Nogal district.

The reconstruction 50-ton amalgamation mill of the Vera Cruz Leasing Co. was operated for a short period.

Whiteoaks district.—During the first three-quarters of the year the Homestake 20-stamp amalgamation mill was operated on ore from the North Homestake and South Homestake mines in the Whiteoaks district.

LUNA COUNTY.

Mine production in Luna County, N. Mex., 1904–1918.

Year.	Ore.	Gold.	Sliver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	1,576	$1,695	8,549	16,000	671,772		$37,606
1905	1,346		5,199		463,956	225,000	38,221
1906	1,994	413	11,265		831,193	103,835	61,673
1907	2,048	13,741	8,633		1,022,773		73,646
1908	288	3	1,077	5,931	127,535		6,713
1909	1,163	3,208	6,916	1,115	682,906		36,314
1910	525	26	2,484	47	298,112		14,490
1911	229	104	1,278	1,814	98,888		5,458
1912	3,090	5,687	24,265		827,556	458,594	89,493
1913	5,185	11,085	41,664	1,453	1,158,682	702,028	126,771
1914	2,127	226	2,975	2,181	416,923	793,588	58,604
1915	2,082	491	2,795	4,080	148,766	861,218	116,405
1916	7,630	3,535	18,077	2,663	868,724	2,725,582	441,255
1917	4,943	5,211	15,142	319	721,117	1,635,500	246,612
1918	2,910	8,214	16,442	3,150	490,493	463,445	102,432
Increase or decrease, 1918	−2,033	+3,003	+1,300	+2,831	−230,624	−1,172,055	−144,190

Cooks Peak district.[1]—Lead carbonate and zinc carbonate and sulphide ores were shipped from the Cooks Peake district. Producing mines were the Summit group, Desdemona-Othello-Monte Cristo group, Contention, Faywood, and Little Mary.

Florida Mountains district.[2]—There was no production from the Florida Mountains district in 1918.

Fremont district.—A car of lead ore was shipped from the International prospect, Fremont district.

Tres Hermanas district.[3]—There was no production from the Tres Hermanas district in 1918.

Victorio (Gage) district.[4]—Lead ore was shipped from the Rambler and the Chance group, Victorio district.

OTERO COUNTY.

Mine production in Otero County, N. Mex., 1904–1918.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	170	$1,050	$1,569	164	14,400		$4,586
1905	117	1,036	41	93	53,602		9,495
1906	268	195	228	533	133,166		26,481
1907	12,203	100	14,711	2,135	679,480		152,116
1908	22,418	1,475	34,215	4,351	723,907		133,552
1909	143	100	157	29	6,354		1,093
1910	2,545	6,022	2,559	2,046	49,874	6,046	16,286
1911	1,096		6,718	715	22,730	739	9,971
1912	3,792	2,034	11,005	1,107	146,588		37,907
1913	25,582	42	49,830	7,088	760,914	1,911	172,179
1914	11,176		38,515	5,761	418,316	2,027	97,416
1915	16,628		54,979	6,255	872,748		210,881
1916	21,838	305	39,525	7,928	1,166,972	17,392	333,321
1917	17,991	737	23,510	4,850	814,736	13,907	251,862
1918	6,270		5,096	2,142	264,417		72,549
Decrease, 1918	11,721	737	18,414	2,708	550,319	13,907	179,313

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[1] Darton, N. H., Geology and underground water of Luna County, N. Mex.: U. S. Geol. Survey Bull. 618, pp. 102–103, 1916.

[2] Darton, N. H., op. cit., pp. 107–108.

[3] Lindgren, Waldemar, The Tres Hermanas mining district, N. Mex.: U. S. Geol. Survey Bull. 380, pp. 123–128, 1909. Darton, N. H., op. cit., pp. 105–106.

[4] Darton, N. H., op. cit., pp. 103–104.

Highrolls (*Sacramento*) *district.*—The production for the Highrolls district decreased heavily from the record productions of 1916 and 1917. One car of copper ore was shipped from the Hutchins prospect.

Jarilla (*Orogrande*, *Silver Hill*) *district.*—Lode mines in the Jarilla district in 1918 produced 6,210 tons of ore yielding $5,096 in gold, 2,048 ounces of silver, and 253,405 pounds of copper, with a total value of $69,735, as compared with $227,028 in 1917. Producing mines were the Delusion, Garnet, Iron Mask, Lucky group, Molly, and Providence. Some of the mines were idle after July. There was no placer production in 1918. Iron ore was shipped to the steel plant at Pueblo, Colo.

Tularosa district.—A few tons of copper ore were shipped from the Hembrillo mine in the Tularosa district.

RIO ARRIBA COUNTY.

No production was made from the copper prospects in Rio Arriba County.

SANDOVAL COUNTY.

Cochiti (*Bland*) *district.*—There was no production in the Cochiti district.

Nacimiento Mountains district.—A few tons of silver-copper ore were shipped from claims in the Nacimiento Mountains district.

SAN MIGUEL COUNTY.

There was no production from San Miguel County in 1918. Development work was carried on by the Pecos Mines Co., at its property at the junction of Willow Creek and Pecos River.

SANTA FE COUNTY.

Mine production in Santa Fe County, N. Mex., 1904–1918.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
		Placer.	Deep.					
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	170	$4,135	$1,292		2,308			$5,727
1905	180	4,002	2,241	42				2,266
1906	128	6,737	7,143	53				13,916
1907	21,338	1,231	16,748	17,635	1,231,200			275,870
1908	7	1,789	242	6				2,034
1909	2,831	1,817	871	2,295	1,093	213,558	4,426	13,415
1910	4,739	4,262	3,877	3,359	5,150	262,023	74,759	26,173
1911	120	2,359	1,325	2,632	16,644	11,178		7,663
1912	15,335	1,302	10,216	14,178	810,563	12,511	10,565	155,272
1913	29,800	129	26,076	22,076	1,798,769	794		319,053
1914	23,584	1,312	9,040	5,723	293,360	52,948	89,860	59,182
1915	27,713	1,567	42,100	24,371	1,704,857	50,638	14,556	358,558
1916	42,683	3,112	66,254	31,871	2,153,610	166,304	334,321	676,399
1917	10,159	2,155	7,152	6,892	400,143	17,779	512,628	178,042
1918	3,915	313	3,981	[a] 5,244	220,846	28,479	94,572	74,715
Increase or decrease, 1918	−6,244	−1,842	−3,171	−1,648	−179,297	+10,700	−418,056	−103,327

[a] Includes 1 ounce of placer silver.

Cerrillos district.—Several cars of zinc sulphide and lead-zinc sulphide ore were shipped from the Tom Payne mine in the Cerrillos district.

New Placers and San Pedro districts.—The mines and the 125-ton matting blast furnace of the Santa Fe Gold & Copper Co. at San Pedro were in operation only the first half of the year.

The Santa Fe Dredging Co. did not operate its traction dredge in 1918. Installation of a floating chain-bucket dredge will begin in 1919, part of the machinery now being on the ground. Various small lots of placer gold from these districts were marketed during the year.

SIERRA COUNTY.

Mine production in Sierra County, N. Mex., 1904–1918.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
		Placer.	Deep.					
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	1,295	$22,979	$51,617	17,055	16,700	....	....	$86,632
1905	3,516	47,878	51,164	8,700	46,664	....	....	11,613
1906	3,216	1,509	16,539	8,102	5,995	....	....	24,633
1907	700	595	7,629	2,250	5,425	9,548	....	11,300
1908	680	1,979	16,039	8,589	12,874	6,075	....	24,524
1909	4,294	....	10,450	25,698	25,838	49,023	....	29,280
1910	8,306	584	11,113	15,778	2,448	11,274	....	21,024
1911	5,036	823	26,962	16,487	5,374	28,088	....	38,459
1912	252	1,546	2,597	11,236	8,988	21,001	....	13,481
1913	269	423	434	2,529	2,568	32,685	....	4,221
1914	98	442	1,305	3,982	14,436	5,743	....	6,093
1915	438	1,757	1,079	316	2,228	24,617	7,492	5,472
1916	935	....	1,468	2,138	14,427	126,609	7,015	16,104
1917	619	331	1,470	8,712	11,828	80,116	....	19,099
1918	801	....	568	18,536	42,053	25,915	....	31,331
Increase or decrease, 1918	+182	−331	−902	+9,824	+30,225	−54,201	....	+12,232

Caballos Mountains district.[1]—Lessees operating the Marion and Gladys mines shipped a small quantity of copper ore.

Chloride (Apache, Cuchillo Negro) district.—A small quantity of lead-copper ore was shipped from the Black Knife group.

Hermosa district.—There was no production from this district.

Hillsboro (Las Animas) district.—A small quantity of copper ore was shipped from the Copper Flat mine.

Kingston (Black Range) district.—One car of copper-lead ore was shipped from the Forest King mine and several cars of gold-silver ore were shipped from the Lady Franklin mine.

Lake Valley district.[2]—Several cars of gold-silver ore were shipped from this district.

Tierra Blanca district.—Several tons of lead-silver ore was shipped from the Roper group.

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[1] Hess, F. L., Vanadium in the Sierra de los Caballos, N. Mex.: U. S. Geol. Survey Bull. 530, pp. 157–160, 1912.

[2] Clark, Ellis, The silver mines of Lake Valley, N. Mex.: Am. Inst. Min. Eng. Trans., vol. 24, pp. 138–167, 1894.

SOCORRO COUNTY.

Mine production in Socorro County, N. Mex., 1911–1918.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1911	128,549	$534,253	1,109,945	79,321	2,124,901	9,930,281	$1,794,086
1912	124,020	525,629	1,126,439	89,776	2,193,178	9,962,478	2,019,300
1913	163,405	623,856	1,347,160	289,566	2,199,247	13,267,811	2,322,188
1914	187,719	631,367	1,424,763	214,722	674,795	13,785,176	2,177,179
1915	195,173	509,653	1,358,000	1,416,098	2,033,728	18,437,218	3,827,776
1916	197,071	375,125	1,081,711	1,013,264	4,424,522	19,312,179	4,229,278
1917	212,729	260,806	859,892	2,699,747	4,886,803	14,716,745	3,627,761
1918	112,947	120,140	352,878	585,717	3,078,380	11,501,879	1,882,926
Decrease, 1918	99,782	140,666	507,014	2,114,030	1,808,423	3,214,866	1,744,835

Magdalena (*Kelly*) *district.*—The production in the Magdalena district for 1918 amounted to 56,295 tons, yielding $430 in gold, 49,835 ounces of silver, 585,482 pounds of copper, 3,033,535 pounds of lead, and 11,501,879 pounds of zinc, having a total value of $1,456,931. The Graphic mine was operated the entire year and the Graphic mill, rebuilt in 1917, was operated for the first three quarters of the year. The Kelly mine was operated the entire year, but the production of zinc carbonates was not equal to that of 1917. The Kelly magnetic separation mill was not operated. Lead and zinc oxidized ores were shipped from the Germany mine and also from the Ambrosia-Juanita property. Zinc and copper sulphide ores were shipped from the Hardscrabble mine.

Mine production in Magdalena district, Socorro County, N. Mex., 1904–1918.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	27,998	$154	5,024	3,200	688,209	17,991,780	$932,658
1905	30,411	....	4,800	320,000	390,000	14,630,051	934,322
1906	35,478	....	2,515	64,560	238,088	17,044,163	1,067,410
1907	3,630	13	4,406	24,045	707,981	676,356	85,158
1908	6,319	72	460	2,605	16,073	3,325,446	157,631
1909	30,724	435	17,925	170,792	3,085,279	12,878,241	860,051
1910	42,232	468	65,800	152,181	3,451,228	16,727,870	1,110,529
1911	25,840	352	42,773	77,448	2,123,039	9,930,281	694,266
1912	22,500	746	32,792	69,532	2,192,792	9,962,478	818,473
1913	47,647	3,942	40,212	278,252	2,198,030	13,267,811	911,069
1914	51,595	2,265	14,436	214,722	674,205	13,785,176	768,144
1915	75,401	488	56,897	1,406,789	2,031,297	18,437,218	2,657,209
1916	78,669	2,036	72,877	993,199	4,421,290	19,312,179	3,187,217
1917	100,709	2,186	137,114	2,690,381	4,885,210	14,716,745	2,770,878
1918	56,295	430	49,835	585,482	3,033,535	11,501,879	1,456,931
Decrease, 1918	44,414	1,756	87,279	2,104,899	1,851,675	3,214,866	1,313,947

Mogollon (*Cooney*) *district.*—The Mogollon district continued to be the chief silver-producing district in New Mexico, with a silver output representing 39 per cent of the State yield. The output of gold from this district represented only 18 per cent of the total output of gold in the State.

The Mogollon Mines Co.'s cyanidation and concentration mill was operated continuously on company ore and custom ore from the Oaks Co. throughout the year, but operations were seriously handicapped by a shortage of water during August, September, and October, and by the influenza epidemic during October and November.

The Socorro Mining & Milling Co.'s cyanidation mill, partly destroyed by fire in 1917, was again ready for operation in August, 1918, with a capacity for the reconstructed mill of 225 tons a day, and for the remainder of the year was operated irregularly on company ore only.

Mine production in Mogollon or Cooney district, Socorro County, N. Mex., 1904–1918.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	11,276	$61,880	79,014	422,308		$162,484
1905	15,534	97,158	240,943	295,175		288,735
1906	16,076	127,907	268,567			307,847
1907	20,698	105,413	418,338	150,000		411,516
1908	19,546	116,418	278,939			264,256
1909	23,945	111,464	249,413	46	49	241,167
1910	50,514	304,210	595,669			625,871
1911	102,219	531,358	1,067,038	1,873	1,862	1,097,206
1912	101,361	524,858	1,093,158	184	386	1,197,197
1913	115,739	619,886	1,306,766	4,418	1,217	1,409,912
1914	136,124	629,102	1,410,327		590	1,409,035
1915	119,710	509,165	1,301,059		2,426	1,168,916
1916	118,257	373,068	1,008,483	858	3,232	1,037,084
1917	111,934	258,620	722,642	414	1,593	854,327
1918	56,452	119,710	302,902	235	282	422,690
Decrease, 1918	55,482	138,910	419,740	179	1,311	431,637

Oscuro Mountains district.—No shipments were made from the Oscuro Mountains district in 1918.

Carthage (Headquarters) district.—The Rim Rock mine and mill, in the Carthage district, were idle during 1918.

TAOS COUNTY.

Copper Mountain (Picuris) district.—The Champion mine, in the Copper Mountain district, was operated only the first half of the year, and the concentration mill on the property was operated during May and June. A car of copper ore was shipped direct to the smelter, but the small quantity of concentrates produced remained unsold. This 25-ton concentration plant, equipped with Dodge crusher, Davis rolls, and a Wilfley table, was later partly dismantled.

Red River district.—Only development work was done in the Red River district. The June Bug mill was leased by the R. & S. Molybdenum Co., in preparation for the treatment of molybdenum ores.

Rio Hondo district.—No work was done on the copper prospects, near Twining, in the Rio Hondo district.

TORRANCE COUNTY.

Carocito district.[1]—From several prospects north of Scholle and west of Mountainair, on the Atchison, Topeka & Santa Fe Railway, were shipped 637 tons of copper ore, carrying 361 ounces of silver and 78,757 pounds of copper. According to Charles T. Kirk, State geologist of New Mexico, Albuquerque, the ores are mainly of the bedded type and occur in the "Red Beds." The ore lies nearly altogether in limestone and shaly limestone, and the minerals are chalcocite, malachite, and azurite.

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[1] See Min. and Sci. Press, Sept. 2, 1916, p. 366.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN TEXAS.[1]

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

The total value of the gold, silver, copper, and lead produced in Texas in 1918 was $580,802, the largest value reported since the beginning of the mining industry of the State in 1884. The yield of silver, the principal metal produced, showed a small decrease in quantity, but the total value for silver at the increased average price was considerably greater than in 1917. The Presidio silver mine, at Shafter, equipped with a large cyanidation mill, continued to produce at approximately its regular annual rate, and its output continued to represent the greater part of the State total.

From the Allamoore-Sierra Blanca district, Hudspeth County, copper and lead ores were shipped, and a car of copper ore was shipped from the Benjamin district, Knox County.

Mine production of gold, silver, copper, lead, and zinc in Texas, 1885–1918.[a]

Period.	Gold.	Silver.		Copper.		Lead.		Zinc.		Total value (commercial).
		Quantity.	Commercial value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
		Fine oz.		*Pounds.*		*Pounds.*		*Pounds.*		
1885-1890	$6,906	1,670,720	$1,652,225	....	....	....	....	....	....	$1,659,131
1891-1900	30,682	4,332,214	2,979,288	42,000	$5,376	7,385	$318	....	....	3,015,664
1901-1910	8,372	8,950,644	2,266,537	85,383	4,647	295,018	13,611	95,957	$5,262	2,293,429
1911	21	424,394	224,929	....	....	122,800	5,526	....	....	230,476
1912	63	406,067	249,731	721	119	65,311	2,939	238,000	16,422	269,274
1913	340	427,553	258,242	34,665	5,373	225,227	9,910	652,607	86,546	310,411
1914	234	530,817	293,542	23,760	3,160	149,027	5,812	216,451	11,039	313,787
1915	1,503	675,473	342,465	42,491	7,436	219,298	10,307	30,395	3,769	365,480
1916	414	653,455	429,973	99,569	24,494	49,927	3,445	232,388	31,140	489,466
1917	22	595,789	490,930	23,132	6,315	2,490	214	22,676	2,313	499,794
1918	25	576,565	576,565	9,308	2,299	26,944	1,913	....	....	580,802
	43,582	14,243,691	9,764,427	311,029	59,219	1,163,427	53,995	1,488,474	106,491	10,027,714
Increase or decrease, 1918	+3	−19,224	+85,635	−13,824	−4,016	+24,454	+1,699	−22,676	−2,313	+81,008

[a] For output by years and authority for each, see U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 236, 1915.

REDUCTION MILLS.

Mineral Resources for 1912, Part I, page 879, contained a complete list of the reduction mills in Texas in 1912, with description of equipment and process. Any changes in this list for 1913–1918 have been noted in the text for the several counties for each year.

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[1] For discussion of the geology of the districts mentioned in the following pages the reader is directed to the bibliography in Mineral Resources, 1912, pt. 1, pp. 876–877, 1913; to Survey Bulletin 507; The mining districts of the western United States, by J. M. Hill, with a geologic introduction by Waldemar Lindgren, 1912; and to Mineral Resources, 1908, pt. 1, pp. 539–540, 1909.

REVIEW BY COUNTIES.[1]

BREWSTER COUNTY.

There were no shipments from the Alpine district.[2] The Metals Products Association began the construction, at Alpine, of a 50-ton smelter for the treatment of lead, silver, and copper ores.

BURNET COUNTY.[2]

No production was made from Burnet County. Some development work was done by the Sheridan Mining Co.

COLEMAN COUNTY.

Some prospecting was done at the Lee Baker farm, near Santa Ana.

CULBERSON COUNTY.[3]

The mining districts of Culberson County were included in El Paso County before 1911. Nothing but prospecting and development work was done in 1918. The Hazel mine, in pre-Cambrian sandstone,[4] was idle.

EL PASO COUNTY.

[See Culbertson and Hudspeth counties.]

FOARD COUNTY.

No work was done in Foard County.

HUDSPETH COUNTY.

Prior to 1917 the mining districts now in Hudspeth County were in El Paso County. A car of copper ore was shipped by the Texas Mining Co., at Allamoore. A car of lead ore was shipped from the Sierra Blanca district. A car of copper ore, which had been mined in 1917, was shipped from the Little Lightning mine.

KING AND KNOX COUNTIES.

A car of copper ore was shipped from the Brazos Wichita Copper Co.'s prospect, near Benjamin, Knox County, from the blue clays of the Permian beds.[5]

PRESIDIO COUNTY.

Shafter district.[6]—Operations were continuous at the Presidio mine, from which the greater part of the silver output of the State has come since 1884. The ore, chiefly silver chloride (horn silver), is treated in a 125-ton cyanidation mill.

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[1] In this section references to discussions of the geology of the several districts are given in the footnotes.

[2] Phillips, W. B., Lead ore in Burnet County, Tex.: Eng. and Min. Jour., vol. 77, p. 364, 1904.

[3] Richardson, G. B., U. S. Geol. Survey Geol. Atlas, Van Horn folio (No. 194), 1913.

[4] Richardson, G. B., Reconnaissance of trans-Pecos Texas: Texas Univ. Mineral Survey Bull. 9, pp. 24–25, 1904. Von Streeruwitz, W. H., Report on the geology and mineral resources of trans-Pecos Texas: Texas Geol. Survey Second Ann. Rept., p. 699, 1891; Texas Geol. Survey Third Ann. Rept., pp. 387–389, 1892.

[5] Cummins, W. F., Notes on the geology of northwest Texas: Texas Geol. Survey Fourth Ann. Rept., pp. 232–238, 1893. Phillips, W. B., Texas Geol. Survey Second Ann. Rept., p. 450, 1890; The Permian copper ores in Texas: Eng. and Min. Jour., Dec. 16, 1911, pp. 1181–1182.

[6] Phillips, W. B., Shafter silver district, Presidio County, Tex.: Eng. and Min. Jour., p. 1303, Dec. 31, 1910. Udden, J. A., The geology of the Shafter silver mine district, Presidio County, Tex.: Texas Univ. Mineral Survey Bull. 8, p. 54, 1904.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN ARIZONA.[1]

(MINES REPORT.)

By V. C. HEIKES.

PRODUCTION.

GENERAL STATEMENT.

In 1918 the mines of Arizona produced ore and placer bullion containing gold, silver, copper, lead, and recoverable zinc valued at $202,134,880. The value of the output, compared with that of 1917, decreased $7,258,922, or about 3.5 per cent. There were 456 producers from deep mines and 13 producers from placers, as against 452 deep-mine and 32 placer producers in 1917. There was an increase in the quantity of copper, but its total value was less, and this decrease in value formed the greater part of the decrease in the State total, though there were also decreases in lead and zinc. Substantial increases, however, were shown in the value of the gold and silver. Dividends paid in 1918 by 18 companies amounted to $36,663,008. The Phelps Dodge Corporation, owning mines in Mexico, New Mexico, and Arizona, paid dividends amounting to $10,800,000 during 1918. This was not included in the State total, as the amount derived from the operations of its properties at Morenci and Bisbee was not reported separately.

Mine production of gold, silver, copper, lead, and recoverable zinc in Arizona in 1917 and 1918.

Year	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	484	15,770,193	$5,068,193	6,983,913	712,166,891	23,465,445	20,894,860	$209,393,802
1918	469	19,038,486	5,435,027	6,686,152	764,855,874	12,503,689	2,269,643	202,134,880
Increase or decrease		+3,268,293	+366,834	−297,761	+52,688,983	−10,961,756	−18,625,217	−7,258,922

[a] Includes placer production.

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[1] The statistical tables in this report were compiled by Bessie N. Patchell, of the United States Geological Survey.

ORE.

Mines in Arizona produced 19,038,486 short tons of ore in 1918, or 3,268,293 tons more than in 1917. The total average value per ton decreased from $13.28 in 1917 to $10.62 in 1918, and the gold and silver value per ton decreased from 69 cents to 64 cents. The dry or siliceous ores decreased from 317,716 tons in 1917 to 295,548 tons in 1918. This classification includes 201,411 tons of siliceous gold ore, averaging $14.48 in gold and 0.63 ounce of silver to the ton. These ores were principally from Mohave and Yavapai counties. There was only 2,415 tons of siliceous material classified as gold and silver ore. The siliceous silver ores produced in 1918 aggregated 91,722 tons, averaging per ton $1.90 in gold, 8.47 ounces of silver, and a little copper and lead. These ores were produced chiefly in the Turquoise and Tombstone districts of Cochise County and in the Verde district of Yavapai County.

The copper ore mined by 234 producers aggregated 18,647,039 tons, against 15,245,297 tons mined by 258 producers in 1917. The larger part of the copper ore mined, or 12,429,042 tons, was from low-grade disseminated deposits near Globe, Ray, and Ajo, where most of the ore was treated. The richer siliceous ore or that valuable as converter lining was shipped to various smelters. There was also similar disseminated ore, 1,744,374 tons in quantity, mined and milled from the low-grade copper deposits in the Clifton and Morenci camps of Greenlee County. Altogether the output of disseminated ores aggregated 14,173,416 tons and yielded 331,696,434 pounds of copper, or more than 43 per cent of the total output of the State. There were mined and smelted directly (without previous concentration) 3,773,935 tons of crude copper ores, averaging 49 cents in gold and 1.19 ounces of silver per ton and 5.21 per cent of copper, with an average value of $27.42 a ton, against 3,679,576 tons in 1917, with an average value of $31.86 a ton. Of the copper ores smelted directly, 2,226,177 tons were sulphides, averaging 64 cents in gold and 1.59 ounces of silver per ton and 5.42 per cent of copper, and having an average value of $29 a ton. The oxidized copper ore smelted, 1,547,758 tons in quantity, contained 27 cents in gold and 0.60 ounce of silver per ton, and 4.91 per cent of copper and was valued at $25.15 a ton. There was a decrease in the quantity of lead ores smelted, which amounted to 19,873 tons in 1918, against 45,940 tons in 1917. The larger part, or 17,132 tons, was oxidized, and 2,741 tons was sulphide ore. The oxidized ores contained $2.79 in gold and 11.71 ounces of silver per ton, 0.48 per cent of copper, and 20.93 per cent of lead and had a total average value of $46.61 a ton. The sulphide lead ores contained $4.17 in gold and 25.85 ounces of silver per ton, 0.70 per cent of copper, and 23.54 per cent of lead. The quantity of zinc ores mined decreased from 62,839 tons in 1917 to 2,129 tons in 1918. All of the zinc ore was of smelting grade, of which 1,229 tons were shipped as sulphides and the remainder (900 tons) as oxidized ores. There were 13,043 tons of lead-zinc ore produced in 1918 by 3 producers. Of this quantity, 12,656 tons were concentrated and yielded 1,328 tons of lead-zinc concentrate and 909 tons of lead concentrate. The lead-zinc ore shipped directly to the smelter, 387 tons in quantity, was nearly all oxidized in character. The copper-lead ore, all of which was shipped to the smelter, amounted to 916 tons in quantity. The larger part (610 tons) was sulphide, there being only 306 tons classified as oxidized. The sulphide ores contained $1.77 in gold and 12.56 ounces of silver per ton, 5.74 per cent of copper, and 12.90 per cent of lead, and had an average value of $61 a ton.

Ore and metals produced in Arizona in 1918.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	13	....	204.82	33	....	....	....
Dry or siliceous ore	121	295,548	149,999.60	917,973	732,519	16,626	....
Copper ore	234	18,647,039	108,750.43	5,347,618	763,766,399	3,465	....
Lead ore	99	79,811	3,689.47	362,182	215,746	11,419,226	....
Zinc ore	8	2,129	3.00	4,560	35,700	35,876	1,269,620
Copper-lead ore	18	916	34.83	17,578	90,374	221,259	....
Lead-zinc ore	3	13,043	237.28	36,208	15,136	807,237	1,000,023
	....	19,038,486	262,919.43	6,686,152	764,855,874	12,503,689	2,269,643

Ore sold or treated in Arizona in 1918, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise	65,015	1,721,527	35,814	31	118	325	1,822,830
Coconino	....	159	....	....	....	....	159
Gila	85	7,807,521	75	....	33	....	7,807,714
Graham	....	331	1,294	....	....	....	1,625
Greenlee	629	2,102,079	17	....	....	....	2,102,725
Maricopa	35	222	60	....	....	....	317
Mohave	183,822	6,277	2,321	147	18	....	192,585
Pima	34	2,031,452	547	869	548	....	2,033,450
Pinal	383	3,606,869	20,799	....	68	....	3,637,119
Santa Cruz	196	84,434	6,057	662	128	12,718	104,195
Yavapai	45,205	1,255,419	781	420	3	....	1,301,828
Yuma	144	30,749	3,046	....	....	....	33,939
	[a] 295,548	18,647,039	79,811	2,129	916	13,043	19,038,486
Value per ton in gold and silver	$13.60	$0.41	$5.49	$2.17	$19.97	$3.15	$0.64

[a] Includes 201,411 tons of gold ore, 2,415 tons of gold and silver ore, and 91,722 tons of silver ore.

GOLD.

Arizona ores, placer dust, and bullion yielded 262,919.43 ounces of gold, valued at $5,435,027, in 1918. Of this value, $4,234, against $17,214 in 1917, came from placers; $3,100,767, against $2,728,632 in 1917, came from dry or siliceous ore; and $2,248,071, against $2,036,816 in 1917, came from copper ores. The mines of Mohave County produced the largest output of gold—$2,798,903 in 1918, against $2,463,178 in 1917. Yavapai County was second, with a production of $1,117,701, against $1,023,464 in 1917. Gold recovered from ores treated in gold and silver mills represented about 53 per cent of the total production, and gold in crude ores shipped to smelters about 38 per cent. From ores treated in mills by amalgamation the gold recovered amounted to $17,481, and that from ores treated by cyanidation to $2,898,040. Concentrates contained $419,589, as against $542,446 in 1917, and ores shipped directly to smelters contained $2,091,292, against $2,003,570 in 1917. The chief producing districts in 1918 were the San Francisco district in Mohave County, where siliceous gold ores were produced, the Warren district in Cochise County, where copper ores were produced, and the Verde district in Yavapai County, producing both siliceous and copper ores.

Of the mines producing in 1918 the United Eastern, at Oatman, was first, with 97,827.45 ounces from siliceous ore. The Tom Reed mine, at Oatman, was second, followed by the United Verde, at Jerome, the Calumet & Arizona and the Copper Queen, at Bisbee, the Blue Bell, in Yavapai County, and the Magma, in Pinal County. Altogether these seven properties yielded about 84 per cent of the total gold.

Mine production of gold in Arizona in 1918, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise		3,243.24	48,129.99	2,259.31		0.10		53,632.64
Coconino			.48					.48
Gila		5.37	6,619.12	30.19		3.70		6,658.38
Graham			.20	6.62				6.82
Greenlee	15.05	83.63	3,744.13					3,842.81
Maricopa		80.78	31.97	.21				112.96
Mohave		134,662.17	114.19	619.56		1.01		135,396.93
Pima	19.88	12.48	11.00	10.50		11.88		65.74
Pinal	10.69	3.49	6,864.98	595.25		5.07		7,480.08
Santa Cruz		58.07	129.04	10.71		12.47	237.28	447.57
Yavapai	105.99	11,747.61	42,056.27	155.92	3.00			54,068.79
Yuma	53.21	102.76	1,049.06	1.20				1,206.23
	204.82	[a] 149,999.60	108,750.43	3,689.47	3.00	34.83	237.28	262,919.43

[a] Includes 141,126.20 ounces from gold ore, 452.21 ounces from gold and silver ore, and 8,421.19 ounces from silver ore.

SILVER.

Silver produced from mines in Arizona decreased from 6,983,913 ounces in 1917 to 6,686,152 ounces in 1918. The value, however, increased from $5,754,744 to $6,686,152 on account of the increased price of the metal. Of this output, 5,347,618 ounces came from copper ore, 917,973 ounces from dry or siliceous ore, 362,182 ounces from lead ore, 36,208 ounces from lead-zinc ore, and smaller quantities from zinc and copper-lead ores. The greatest increase of silver was in Yavapai, Greenlee, Santa Cruz, and Pinal counties, principally from copper ores. Bullion recovered from gold and silver ores, largely by cyanidation, yielded 158,476 ounces of silver in 1918. Concentrates contained 1,109,510 ounces, and crude ore shipped to smelters contained 5,372,505 ounces, representing more than 80 per cent of the total output. Yavapai County mines led in output of silver, producing 2,502,968 ounces of silver in 1918, against 2,207,583 ounces in 1917. Cochise County produced 2,315,518 ounces of silver in 1918, against 2,707,220 ounces in 1917 and 3,709,225 ounces in 1916.

More than half of the total silver came from the ore of five important copper properties. The United Verde, at Jerome, was first in 1918, followed by the Calumet & Arizona and the Copper Queen, both at Bisbee, the United Verde Extension, at Jerome, and the Magma, in Pinal County.

Mine production of silver in Arizona in 1918, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise	....	426,019	1,693,598	195,193	....	708	....	2,315,518
Coconino	....	....	846	....	....	....	....	846
Gila	....	583	474,965	838	....	655	....	477,041
Graham	....	....	452	27,995	....	....	....	28,447
Greenlee	3	12,581	129,775	40	....	....	....	142,399
Maricopa	....	123	136	455	....	....	....	714
Mohave	....	81,389	7,750	25,267	....	301	....	114,707
Pima	5	332	111,850	4,422	....	11,790	....	128,399
Pinal	3	46,426	611,016	31,082	....	2,160	....	690,687
Santa Cruz	....	7,955	199,934	22,559	2,600	1,941	36,208	271,197
Yavapai	14	342,027	2,114,660	44,284	1,960	23	....	2,502,968
Yuma	8	538	2,636	10,047	....	....	....	13,229
	33	[a] 917,973	5,347,618	362,182	4,560	17,578	36,208	6,686,152

[a] Includes 127,774 ounces from gold ore, 12,896 ounces from gold and silver ore, and 777,303 ounces from silver ore.

COPPER.

The production of copper from Arizona mines amounted to 764,855,874 pounds, valued at $188,919,401, in 1918, against 712,166,891 pounds, valued at $194,421,561, in 1917. There was, therefore, an increase of 52,688,983 pounds in quantity and a decrease of $5,502,160 in value. Crude ore shipped directly to the smelters yielded 394,382,678 pounds, or nearly 52 per cent of the total quantity, against 412,030,793 pounds in 1917. Of the output from crude ore smelted in 1918, Cochise County produced about 43 per cent. Yavapai, Gila, Pinal, Greenlee, and Pima counties also produced large quantities. The copper in concentrates produced at milling plants increased from 282,146,701 pounds in 1917 to 325,058,915 pounds in 1918. This increase was made largely in Gila and Greenlee counties. Gila County, including the Globe and Miami districts, produced altogether 173,897,683 pounds of copper in concentrates, against 141,554,598 pounds in 1917, 189,299,027 pounds in 1916, 77,085,710 pounds in 1915, 73,488,162 pounds in 1914, 71,609,847 pounds in 1913, 63,969,423 pounds in 1912, and 49,226,341 pounds in 1911. The low-grade disseminated ores in Pima, Pinal, and Gila counties yielded 280,202,381 pounds of copper, against 146,547,980 pounds in 1917, 244,675,654 pounds in 1916, 124,264,911 pounds in 1915, 95,485,293 pounds in 1914, 87,073,406 pounds in 1913, 68,753,553 pounds in 1912, and 30,666,515 pounds in 1911. Similar low-grade copper deposits exist in Greenlee County, whose output added made the total production from the disseminated deposits in Arizona 331,696,434 pounds, or about 43 per cent of the aggregate output in 1918. In 1917 these ores altogether produced 284,100,353 pounds of copper.

Thirteen properties, or the same number as in 1917, produced about 88 per cent of the total quantity of copper, each of them yielding more than 10,000,000 pounds. The Inspiration, at Miami, was first, with 98,540,041 pounds, followed by the Copper Queen, in Cochise County, with 90,988,156 pounds; Ray Consolidated, in Pinal

County, with 84,746,288 pounds; and the United Verde, in Yavapai County. Those closely following were the Miami, United Verde Extension, Calumet & Arizona, New Cornelia, Arizona Copper, Old Dominion, Detroit Copper, Magma, and Iron Cap mines.

The conditions of the copper industry have been reviewed by Douglas,[1] as follows:

> The 23½-cent price agreed upon between the copper producers and the Government Price Fixing Committee on September 21, 1917, remained in force until July, 1918, when an increase of 2½ cents a pound was permitted, to take care of increased costs created by the raise in freight rates and higher tolls demanded by the refiners. A wage increase amounting to 75 cents a day was also at that time granted to all classes of labor in the industry as a compensation for the increased cost of living. The average copper quotation for 1918 was 24.7 cents, or 2.6 cents less than in 1917; though the cost of production, owing to the above factors, together with marked decrease in labor efficiency, increased greatly.

Mine production of copper in Arizona in 1918, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise	66,514	169,251,600	84,752	....	16,054	....	169,418,920
Coconino	....	48,036	....	....	....	....	48,036
Gila	1,598	207,636,758	871	....	4,525	....	207,643,252
Graham	....	35,173	65,905	....	....	....	101,078
Greenlee	2,887	71,865,801	....	....	....	....	71,868,688
Maricopa	....	37,206	891	....	....	....	38,097
Mohave	2,683	517,461	7,328	....	874	....	528,346
Pima	679	59,975,730	2,931	....	44,789	....	60,024,129
Pinal	10,378	98,557,718	17,470	....	12,574	....	98,598,140
Santa Cruz	624	5,278,154	34,036	28,000	11,326	15,136	5,367,276
Yavapai	646,216	148.226,485	2,062	7,700	232	....	148,882,695
Yuma	940	2,336,277	....	....	....	....	2,337,217
	[a] 732,519	763,766,399	215,746	35,700	90,374	15,136	764,855,874

[a] Includes 5,872 pounds from gold ore, 3,947 pounds from gold and silver ore, and 722,700 pounds from silver ore.

LEAD.

The mine production of lead in Arizona in 1918 was 12,503,689 pounds, valued at $887,762, against 23,465,445 pounds, valued at $2,018,028, in 1917, a decrease of 10,961,756 pounds in quantity and of $1,130,266 in value. Cochise County, principally the Warren or Bisbee district, although responsible for the decrease in quantity, had the largest yield of lead, or 4,310,288 pounds, valued at $306,030, as against 11,262,440 pounds, valued at $968,570, in 1917. Pinal County followed with 3,854,756 pounds, Santa Cruz County with 1,453,557 pounds, and Graham County with 1,174,860 pounds. Concentrates derived from low-grade ores produced 3,694,916 pounds of lead, and crude ores shipped directly to smelters produced 8,790,305 pounds.

Four mines in Arizona produced more than 63 per cent of the total output of lead in 1918, and each of these produced more than 1,000,000 pounds of lead. They were the Ray Silver-Lead mine, near Ray, the Shattuck mine and the Copper Queen mines, at Bisbee, and the Grand Reef mine, in Graham County.

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[1] Douglas, Walter, Copper production in Arizona in 1918: Eng. and Min. Jour., vol. 107, pp. 49–50, Jan. 11, 1919.

Mine production of lead in Arizona in 1918, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise	554		4,256,749		21,285	31,700	4,310,288
Gila			30,643		21,162		51,805
Graham			1,174,860				1,174,860
Greenlee			10,026				10,026
Maricopa			53,484				53,484
Mohave	2,174		580,645	1,690	3,305		587,814
Pima			257,543		110,629		368,172
Pinal			3,808,744		46,012		3,854,756
Santa Cruz	8,773	3,465	629,594	17,986	18,202	775,537	1,453,557
Yavapai	5,125		326,400	16,200	664		348,389
Yuma			290,538				290,538
	[a]16,626	3,465	11,419,226	35,876	221,259	807,237	12,503,689

[a] Includes 67 pounds from gold ore and 16,559 pounds from silver ore.

ZINC.

The mine output of recoverable zinc from Arizona zinc-bearing ores in 1918 amounted to 2,269,643 pounds, valued at $206,538, against 20,894,860 pounds, valued at $2,131,276, in 1917. The Montana property, in Santa Cruz County, worked by lessees in 1918, was the largest producer of zinc, followed by the Rosemont property, near Helvetia, in Pima County. There was also some zinc produced from the Arizona Hillside property, in Yavapai County. Ores milled yielded 849,293 pounds of zinc from concentrates, the remainder (1,420,350 pounds) being from first-class or shipping ore.

Mine production of recoverable zinc in Arizona, in 1918, in pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Cochise	7,378	132,500	139,878
Mohave	82,853		82,853
Pima	540,027		540,027
Santa Cruz	281,982	867,523	1,149,505
Yavapai	357,380		357,380
	1,269,620	1,000,023	2,269,643

Zinc ore and concentrates from Arizona mines and mills sold in 1918.

Classification.	County.	Quantity.	Average assay of ore and concentrate.[a]
		Short tons.	*Per cent of zinc.*
Sulphide zinc ore	Mohave, Santa Cruz, and Yavapai	1,229	34.57
Sulphide lead-zinc ore	Santa Cruz	[b]62	17.30
Oxidized zinc ore	Cochise and Pima	900	35.78
Oxidized lead-zinc ore	Cochise	[c]325	23.98
Lead-zinc concentrates	Santa Cruz	1,328	37.62
		3,844	34.73

[a] Actual assay content.
[b] Averaged 15.19 per cent of lead and was shipped to a zinc oxide plant in Colorado.
[c] Contained 4.88 per cent of lead and was shipped to Kansas for manufacture of zinc oxide.

MINING INDUSTRY.

In 1918 the mining and smelting companies in Arizona experienced a shortage of labor, increasing wages, and high cost of supplies. The labor scarcity was at its worst in the last two months of the year, owing to the universal epidemic of influenza. Only one labor strike of importance occurred—in February, at the Hayden plant of the American Smelting & Refining Co.—and the trouble was quickly settled. According to a prominent mine operator,[1] in Arizona every mining property was pushed to its capacity to get out the maximum quantity of ore, and was thus compelled to neglect or postpone its development and exploratory work, so that it is probable, with the pressure removed, the metal production of 1919 will show a very material decrease. Inability to obtain material for construction or repairs seriously affected the efficiency of the plants, and it will probably take at least six months or a year of heavy expenditures of capital and labor to restore their physical condition to that of the pre-war period both above and below ground.

There were 12 copper-smelting plants in operation in 1918, as follows: Copper Queen and Calumet & Arizona, at Douglas; Sasco smelter, near Silver Bell; American Smelting & Refining Co., at Hayden; Consolidated Arizona, at Humboldt; International, at Miami; Old Dominion, at Globe; Detroit, at Morenci; Arizona Copper and Shannon, at Clifton; United Verde, at Clarkdale; and United Verde Extension, at Verde. The Shannon smelter was closed shortly after the end of the year, and the Sasco smelter was closed early in 1919. On July 18, 1918, the first unit of the United Verde Extension smelter was blown in.

REDUCTION MILLS.

Forty-three milling plants of various kinds were in operation in Arizona in 1918, but only a few continuously. Four mills used straight amalgamation; 3, amalgamation and concentration; 9, only cyanidation; 1, cyanidation and concentration; 26, concentration, of which 10 were equipped for table concentration only, 15 for table and flotation concentration, and 1 for straight flotation only. In addition there were 4 leaching plants and 2 precipitating plants recovering copper from solutions. A list giving all the mills in commission, including many new plants under construction in 1911 and 1912, was published in Mineral Resources for 1911, Part I, page 426, and for the year 1917 in Mineral Resources for 1917, Part I, pages 549–556.

The ore treated in 1918 by amalgamation amounted to 1,389 tons and produced 845.66 ounces of gold and 451 ounces of silver, an average recovery per ton of $12.59 in gold and 0.32 ounce of silver. Ores treated by cyanidation amounted to 202,265 tons, which, with 19,243 tons of old tailings, produced 140,192.75 ounces of gold and 158,025 ounces of silver, or an average recovery per ton from ore and tailings of $13.08 in gold and 0.71 ounce of silver. The total value of the bullion recovered from ore and tailings was $3,073,999, as against $2,703,365 in 1917. During 1918 there were 157,829 pounds of sodium cyanide consumed at milling plants. This corresponds to 0.53 pound per ounce of gold and silver and 0.71 pound per ton of ore and tailings treated.

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[1] Douglas, Walter, Copper production in Arizona, 1918: Eng. and Min. Jour., vol. 107, pp. 49–50, Jan. 11, 1919.

Gold and silver produced at mills in Arizona in 1918.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Cochise	785	....	....	a 306.12	a 20,565	$26,893
Gila	23	5.37	....	....	211	322
Greenlee	10	....	....	5.00	250	353
Maricopa	30	12.33	50	10.94	8	539
Mohave	183,244	70.85	170	b 134,337.07	b 71,270	2,849,899
Santa Cruz	45	39.96	15	....	....	841
Yavapai	c 19,428	633.59	191	5,531.62	65,671	193,308
Yuma	89	83.56	25	2.00	50	1,844
	203,654	845.66	451	140,192.75	158,025	3,073,999

a Includes bullion from 19.027 tons of old tailings.
b Includes bullion from 216 tons of old tailings.
c Also yielded 28 tons of concentrates.

Concentration plants reduced 13,125,101 tons of ore to 865,232 tons of concentrates, which were shipped to smelters, and produced $419,589 in gold, 1,109,510 ounces of silver, 325,058,915 pounds of copper (or about 42 per cent of the total output of copper in the State), 3,694,916 pounds of lead, and 849,293 pounds of recoverable zinc, valued in all at $82,158,276, a total average value per ton of $94.96. Copper concentrates amounting to 854,714 tons comprised more than 99 per cent of the total concentrates produced.

Mine production of metals from Arizona concentrates in 1918.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value of concentrates.
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Cochise	33,895	7,434	735.07	105,518	81,158	1,876,794	....	$274,011
Gila	7,470,382	320,490	3,644.00	244,529	173,897,683	....	....	43,272,585
Greenlee	1,836,584	229,679	2,535.00	79,789	54,204,553	....	....	13,520,716
Mohave	4,670	272	23.29	4,030	37,520	9,657	....	14,465
Pinal	3,555,715	259,337	5,338.00	411,108	87,689,023	507,169	....	22,216,652
Santa Cruz	60,937	5,497	239.80	39,626	1,257,680	1,108,284	849,293	511,204
Yavapai	159,978	42,246	7,781.34	216,516	7,891,298	....	....	2,326,522
Yuma	2,940	277	1.10	8,394	....	193,012	....	22,121
	13,125,101	865,232	20,297.60	1,109,510	325,058,915	3,694,916	849,293	82,158,276

By kinds of concentrates.

Dry or siliceous	....	4,379	340.32	110,829	16,372	554	....	$121,947
Copper	....	854,714	18,893.66	872,922	325,018,774	....	....	81,543,126
Lead	....	4,811	963.62	103,759	16,912	3,544,362	....	379,506
Lead-zinc	....	1,328	100.00	22,000	6,857	150,000	849,293	113,697

Of the material smelted, the crude ore was the largest part—3,845,332 tons. It contained the following quantities of recoverable metals: 101,166.27 ounces, or $2,091,292, in gold, 5,372,505 ounces of silver, 394,382,678 pounds of copper, 8,790,305 pounds of lead, and 1,420,350 pounds of zinc, valued in all at $105,629,682, or an average value per ton of $27.47. The copper ores constituted the largest part of the crude ores smelted, aggregating 3,773,935 tons, of which the Warren or Bisbee district, in Cochise County, produced more than 42 per cent. The dry or siliceous ores formed the next largest quantity—48,092 tons, followed by lead ores—19,873 tons, the latter being produced largely in the Warren or Bisbee district of Cochise County.

Mine production of metals from Arizona crude ore shipped to smelters in 1918.

By counties.

County.	Crude ore to smelter.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Cochise	1,752,728	52,420.98	2,145,406	168,450,158	2,433,494	139,878	$45,021,740
Coconino	159	.48	846	48,036			12,721
Gila	337,309	3,009.01	232,301	33,745,569	51,805		8,633,336
Graham	1,625	6.82	28,447	101,078	1,174,860		136,969
Greenlee	216,369	1,287.76	62,357	15,891,606	10,026		4,014,916
Maricopa	287	89.69	656	38,097	53,484		15,717
Mohave	3,455	965.72	39,237	435,434	578,157	82,853	215,341
Pima	258,450	45.86	128,394	17,768,821	368,172	540,027	4,593,524
Pinal	81,404	2,131.39	279,576	10,909,117	3,347,587		3,255,866
Santa Cruz	43,195	167.21	230,798	4,109,237	326,805	300,212	1,299,758
Yavapai	1,119,441	39,974.99	2,219,735	140,548,308	348,389	357,380	37,818,781
Yuma	30,910	1,066.36	4,752	2,337,217	97,526		611,013
	3,845,332	101,166.27	5,372,505	394,382,678	8,790,305	1,420,350	105,629,682

By kinds of ore.

Dry or siliceous	48,092	8,411.13	604,054	713,409	16,072		$955,280
Copper	3,773,935	89,854.79	4,474,440	393,336,441	3,465		103,486,250
Lead	19,873	2,862.53	271,476	204,473	8,463,089		982,035
Zinc	2,129	3.00	4,560	35,700	35,876	1,269,620	131,523
Copper-lead	916	34.82	17,578	90,374	221,259		56,329
Lead-zinc	387		397	2,281	50,544	150,730	18,265

PRODUCTION BY COUNTIES.

GENERAL STATEMENT.

The following tables show the State output by counties in 1918, the production of each metal, and the total value; also the production of ore and the average value per ton, by counties, 1917 and 1918. The tables are followed by a review of the mining industry of each county and each producing mining district.

Ore sold or treated, number of deep mines producing, and average value of ore per ton in Arizona in 1917 and 1918.

County.	Ore sold or treated, 1918.		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	Quantity.	Increase or decrease.	1917	1918	1917	1918	1917	1918
	Short tons.	*Short tons.*						
Cochise	1,822,830	− 92,103	53	52	$27.51	$25.01	$1.77	$1.88
Coconino	159	− 1,352	6	4	65.12	80.01	2.51	5.38
Gila	7,807,714	+1,758,170	50	45	8.01	6,65	.09	.08
Graham	1,625	− 10,949	13	7	23.08	84.29	2.27	17.60
Greenlee	2,102,725	+ 671,607	17	22	10.21	8.55	.08	.11
Maricopa	317	− 1,235	14	7	36.91	51.28	20.06	9.62
Mohave	192,585	− 82,980	59	60	19.20	16.07	10.05	15.13
Pima	2,033,450	+1,037,541	61	54	9.78	7.39	.14	.06
Pinal	3,637,119	− 161,612	26	33	7.61	7.00	.19	.23
Santa Cruz	104,195	+ 39,316	26	41	25.61	17.41	2.86	2.69
Yavapai	1,301,828	+ 125,184	75	88	39.58	31.07	2.41	2.78
Yuma	33,939	- 13,294	52	43	21.95	18.71	.90	1.09
	19,038,486	+3,268,293	452	456	13.28	10.62	.69	.64

[a] Placer product excluded.

Mine production of gold, silver, copper, lead, and zinc in Arizona in 1918.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.		
	Quantity.	Value.	Quantity.	Value.		Quantity.	Value.
	Fine ounces.		*Fine ounces.*			*Fine ounces.*	
Cochise			53,632.64	$1,108,685	$1,108,685	2,315,518	$2,315,518
Coconino			.48	10	10	846	846
Gila			6,658.38	137,641	137,641	477,041	477,041
Graham			6.82	141	141	28,447	28,447
Greenlee	15.05	$311	3,827.76	79,127	79,438	142,399	142,399
Maricopa			112.96	2,335	2,335	714	714
Mohave			135,396.93	2,798,903	2,798,903	114,707	114,707
Pima	19.88	411	45.86	948	1,359	128,399	128,399
Pinal	10.69	221	7,469.39	154,406	154,627	690,687	690,687
Santa Cruz			447.57	9,252	9,252	271,197	271,197
Yavapai	105.99	2,191	53,962.80	1,115,510	1,117,701	2,502,968	2,502,968
Yuma	53.21	1,100	1,153.02	23,835	24,935	13,229	13,229
	204.82	4,234	262,714.61	5,430,793	5,435,027	6,686,152	6,686,152

Mine production of gold, silver, copper, lead, and zinc in Arizona in 1918—Contd.

County.	Copper.		Lead.		Recoverable zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Cochise	169,418,920	$41,846,473	4,310,288	$306,030	139,878	$12,729	$45,589,435
Coconino	48,036	11,865					12,721
Gila	207,643,252	51,287,883	51,805	3,678			51,906,243
Graham	101,078	24,966	1,174,860	83,415			136,969
Greenlee	71,868,688	17,751,566	10,026	712			17,974,115
Maricopa	38,097	9,410	53,484	3,797			16,256
Mohave	528,346	130,501	587,814	41,735	82,853	7,540	3,093,386
Pima	60,024,129	14,825,960	368,172	26,140	540,027	49,142	15,031,000
Pinal	98,598,140	24,353,741	3,854,756	273,688			25,472,743
Santa Cruz	5,367,276	1,325,717	1,453,557	103,203	1,149,505	104,605	1,813,974
Yavapai	148,882,695	36,774,026	348,389	24,736	357,380	32,522	40,451,953
Yuma	2,337,217	577,293	290,538	20,628			636,085
	764,855,874	188,919,401	12,503,689	887,762	2,269,643	206,538	202,134,880

COCHISE COUNTY.

Mine production in Cochise County, Ariz., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	53	1,914,933	$1,149,782	2,707,220	176,814,981	11,262,440	608,443	$52,681,652
1918	52	1,822,830	1,108,685	2,315,518	169,418,920	4,310,288	139,878	45,589,435
Decrease, 1918		92,103	41,097	391,702	7,396,061	6,952,152	468,565	7,092,217

The total average value per ton of the ore in Cochise County decreased from $27.51 in 1917 to $25.01 in 1918, but the gold and silver value in this ore increased from $1.77 to $1.88. All the metals, with the exception of silver, decreased in quantity and value. The value of the silver increased from $2,230,749 in 1917 to $2,315,518 in 1918. Gold decreased from $1,149,782 in 1917 to $1,108,685 in 1918; copper, from $48,270,490 in 1917 to $41,846,473 in 1918; lead, from $968,570 to $306,030; recoverable zinc, from $62,061 to $12,729. Ores of smelting grade, of which there were 1,752,728 tons, predominated and contained $1,083,638 in gold, 2,145,406 ounces of silver, 168,450,158 pounds of copper, 2,433,494 pounds of lead, and 139,878 pounds of zinc, valued in all at $45,021,740, or an average value per ton of $25.69. Of the ores smelted there were 1,720,031 tons classified as copper ore, of which 810,458 tons were estimated to be oxidized ores and 909,573 tons sulphide ores. All of the lead ores smelted, 8,478 tons in quantity, were shipped to plants outside of the State and contained 1,549.84 ounces of gold, 128,601 ounces of silver, 84,752 pounds of copper, and 2,380,509 pounds of lead. All of this ore was oxidized, with the exception of 121 tons classified as sulphide ore. No placer gold was reported in 1918, although placering is known to have been productive in the Ash Canyon region of the Huachuca Mountains.

California district.—Altogether there were 125 tons of shipping ore, containing copper and lead, produced from properties in the California district. One lot of ore from the Cochise property contained zinc, which was shipped to an eastern plant. The principal producers of lead-copper ore were the Horace and Ajax claims.

Cochise or Johnson district.—Eleven producers reported the output in 1918 of 44,908 tons of ore, containing $105 in gold, 36,757 ounces of silver, 4,174,304 pounds of copper, and 4,579 pounds of lead, valued in all at $1,068,240, or an average value per ton of $23.79. All of this ore was of shipping grade and came principally from the Mammoth and Republic properties. There were also important shipments from the Copper Chief, Black Prince, and Peabody mines; also smaller quantities from the Keystone, Centurion, and Silver King properties. The figures of production of ore from the Middlemarch property are also included in this district. It is reported that the smelter of the Arizona Smelting & Power Co. at Benson, is expected to treat much of the ore produced in the district, commencing the last part of 1919.

Dos Cabezas district.—From the Mascot property low-grade copper ore was shipped to the smelter at Sasco and a small quantity to El Paso, Tex. The only other ore shipped was from the Oneida and Henry Clay claims, the former yielding some lead ore.

Hartford district.—Three producers reported the production of 584 tons of ore, all of which, with the exception of 134 tons, shipped directly to smelters, was milled and yielded silver concentrate containing a little lead and copper. The principal part of the output came from the Black Eagle claim.

Huachuca district.—Tungsten ores were concentrated and a considerable output of scheelite concentrate was shipped from this district. It is also reported[1] that a quantity of placer gold was recovered from the gulches near Garces, in Ash Canyon, but no reports of these operations were received by the Geological Survey for 1918.

Rincon Mountain district.—The smelter under construction at Benson is owned by a company developing properties in this district. A small tonnage of slag from the old dump at Benson was shipped for testing in 1918.

Swisshelm district.—During 1918 a few cars of high-grade oxidized lead ore, containing silver and gold, were shipped during development from the property of the Swisshelm Gold Mines Co. This mine is opened by an inclined shaft and has numerous crosscuts and drifts.

Tombstone district.—There were shipped or treated in the district 19,507 tons of ore, containing $28,719 in gold, 283,412 ounces of silver, 41,503 pounds of copper, and 457,183 pounds of lead, valued in all at $354,892. The larger part of the ore, or 13,885 tons, containing lead, copper, and silver, was shipped directly to the smelter; 785 tons were treated by cyanidation; and 4,837 tons were treated in a concentration mill. The principal part of the district output was from the Bunker Hill properties, which yielded several classes of ore, chiefly manganese ore, which was shipped to various plants, the first-class ore to steel works in the Eastern States, and the second-class to the copper smelter at Douglas. The Bunker Hill concentration and cyanidation mill was operated during the first three months of 1918. Active mining at the Bunker Hill properties[1] ceased in April, 1918, and operations after that time consisted of development work. At the same time opportunity was given to lessees to prospect and develop likely pieces of ground in the mine. The ore produced by lessees and the company aggregated 19,312 tons, containing 1,334.99 ounces of gold, 276,007.35 ounces of silver, 448,616 pounds of lead, 39,208 pounds of copper, and 834,337 pounds of manganese. These metals were contained in 3,113 tons of silver-lead ore shipped to El Paso and 10,577 tons of ore containing silver, gold, and a little copper. Manganese concentrate, containing principally silver and a little copper, was shipped to Douglas. The better grade of manganese was shipped to eastern markets, and at the cyanide plant on the property 785 tons of silver-gold ore yielded bullion.

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[1] Communication from bullion dealers to the writer.

Some ore was also shipped from the Luck Sure and Solstice properties.

Turquoise district.—Operators of 9 properties in 1918 reported the production of 119,934 tons of ore, which included 35,110 tons of old tailing containing gold and silver, part of which was milled and part shipped to the smelter for converter lining. There was also some silver bullion recovered, but the bulk of the output of the district, consisting of 84,824 tons of ore, was shipped directly to the smelters and contained 4,549.31 ounces of gold, 237,145 ounces of silver, 4,365,969 pounds of copper, and 20,725 pounds of lead. The total output of the district was valued at $1,481,668. Most of the ore contained copper and was mined from the Copper Bell property and shipped to the smelter at Clifton. Besides the copper, this ore contained considerable silver and gold. The Germania, Copper Rock, Great Western, Tejon, and Maid of Sunshine properties also produced copper ore. Silver ore, containing copper and gold, was shipped directly to the smelter from the Commonwealth mine, as well as old tailings, which were both milled and shipped.

Warren or Bisbee district.—Mines of the district, of which there were 11 producing in 1918, reported 1,632,210 tons of ore, containing $968,560 in gold, 1,682,800 ounces of silver, 160,455,639 pounds of copper, 3,726,022 pounds of lead, and 132,500 pounds of zinc, valued at $42,560,509, or an average value per ton of $26.08. Included in shipments were 224 tons of old slag, containing some silver and copper. Of the crude ore produced, 1,603,378 tons were shipped directly to the smelters and 28,608 tons were milled and produced lead concentrate containing copper, silver, and some gold. The principal producers were the Copper Queen and the Calumet & Arizona properties. There were also large quantities of ore shipped from the Shattuck, Denn, Higgins, Wolverine, and a number of smaller properties.

The Copper Queen mines,[1] according to the annual report of the company, produced 770,524 tons of ore of various kinds, divided as as follows:

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[1] Phelps Dodge Corporation Ann. Rept. for year ending Dec. 31. 1918.

Ore and metals produced at Copper Queen mines, 1918.

Kind of material and destination.	Quantity.	Gold.	Silver.	Copper.	Lead.
Shipped to Douglas:	*Short tons.*	*Ounces.*	*Ounces.*	*Pounds.*	*Pounds.*
Copper ore—					
Company ore	692,591	15,875	471,637	85,094,221	....
Lease ore	66,585	188	58,682	4,847,245	....
Sortings	466	4	129	13,309	....
Shipped to El Paso:					
Silver-lead ore:					
Company ore	108	6	2,030	25,822	48,619
Lease ore	3,363	330	25,747	49,881	1,185,878
To experimental concentrator:					
Copper ore	1,272	....	....	....	....
Shipped to Chicago:					
Manganese ore	5,058	....	....	....	....
	769,443	....	....	....	....
Miscellaneous:					
Precipitates	915	....	61	876,380	....
Neptune slag	166	....	24	6,223	....
	770,524	....	....	....	....
Concentrates:					
Copper to Douglas	539	6	123	75,075	....
Total, 1918	....	16,409	558,433	90,988,156	1,234,497
Total, 1917	....	19,156	828,665	93,618,409	6,870,128
Total, 1916	....	24,030	1,096,136	102,685,722	9,421,562

There was a material increase in copper production from Copper Queen leases, amounting to almost two million pounds. An increased tonnage of manganese ore was shipped from the mines during the year. Lead ore shipments to El Paso dropped off very markedly on account of the lower price of lead, the higher treatment charges, and the shortage of labor. Practically all the old slag that it will pay to ship has been cleaned up. * * *

The total footage of exploration and development work was 58,360 feet, as compared with 58,518 feet in 1917. Although, on account of the shortage of labor experienced during the greater part of the year, the proportion of exploration and development to tonnage mined was lower than usual, the tonnage of ore developed per foot of exploration work was notably high; and as a consequence, there was at the end of the year a most gratifying increase in the ore reserves of the limestone mines. While practically all divisions of the mine have developed their ore reserves most satisfactorily, the continued extension of the new ore body in the Southwest is worthy of note, as is also the encountering of very good grade ore in the Gardner mine on the 1,000 level. This latter ore is undoubtedly a downward extension of the Sacramento Hill east ore body and constitutes the most important development of the year.

During 1918 mining costs showed the marked increase that was natural, in view of constantly increasing wages and the high cost of supplies of all kinds. Underground efficiency was below normal.

The Calumet & Cochise shaft was sunk from the 1,000 level to the 1,500 level. Very little water has been developed in this shaft to date.

The White Tail Deer operations were suspended in the middle of the year, as men could be used to better advantage in other parts of the mine.

In October a very disastrous fire completely destroyed the mine warehouse and most of its contents.

In the past year 1,099,660 cubic yards of waste were stripped and moved from Sacramento Hill. The yardage removed to January 1, 1919, constitutes 30.8 per cent of the total waste to be stripped. Toward the end of the year a satisfactory reduction in costs was made. The nature of the ground has gradually improved, and in addition the organization is showing a much better efficiency. A continued improvement may be expected during the coming year. * * *

On the site of the new concentrator the grading work has been practically completed, with the exception of the excavation for the power house. Construction of the concentrator will be postponed until metal market conditions improve and the cost of materials justifies its erection.

The Calumet & Arizona mines,[1] produced 676,888 dry tons of ore, of which 580,339 dry tons were shipped to the smelter at Douglas. Sales of ore with high sulphur and low copper content were made to various smelters for use in fluxing; 5,793 tons of manganese ore were sold to steel manufacturers in the Eastern States; 254 tons of lead-zinc ore were sold to paint makers; and 79 tons of lead ore to the lead smelter at El Paso, Tex. In addition to its own ores, the company smelted 245,443 dry tons of ore from mines in Arizona and New Mexico. There was produced from the company ore sold or treated 50,909,373 pounds of fine copper, 906,210 ounces of silver, and 31,307.66 ounces of gold. Dividends paid in 1918 amounted to $5,140,062. Altogether since 1903, including 1918, there have been paid by the company dividends amounting to $41,132,823.75. The company report contains the following paragraphs:

> Precious metals per ton of refined copper from our own ores amounted to $59. * * *
>
> The wages of the men have increased with a decided departure from the sliding scale on account of the awards of the Government mediator and in connection with the fixation of the price of copper by the War Board. When the price of copper was first fixed at 23½ cents it was understood that the 26-cent scale was to remain in force. Following the fixing of the 23½-cent price the cost of living increased and the cost of producing copper increased, and when the price of 26 cents was established, although the War Board merely stipulated that wages should not be less than paid before, it was evident certain wage increases were necessary (because of the increased cost of living), with the result that labor was increased in Arizona by 75 cents per shift. As a consquence, from July, 1918, the wages paid were those called for by the sliding scale when copper sold at 32 cents, whereas the price received for copper actually sold was 26 cents as stated.
>
> The supply of labor throughout the year has been inadequate. The average number of men employed underground prior to June, 1917, was about 1,450 with a surplus of miners, whereas during the year 1918 the average was about 1,140 with no surplus. With this scarcity of labor there was a marked decrease in efficiency, which is estimated to have been fully 30 per cent less than when the labor supply has been abundant.
>
> During the first six months of 1917 there was 1 foot of development work for each 6.5 tons of ore mined, whereas during the last half of the year 1917 12 tons of ore were mined for each 1 foot of development. During the year 1918 there were mined 8.5 tons of ore per foot of development by drifting, raising, etc. In addition to this ordinary development 16,281 linear feet were drilled by diamond drill. * * *
>
> The smelter has worked continuously with a decided falling off in tonnage of custom ore as well as of domestic ore. As the ore is mined from deeper levels there is less and less oxidized ore and more sulphide, and it is becoming evident that it will be more advantageous for us to smelt all of our ore in reverberatory furnaces if we can solve the problem of crushing the lump ore cheaply and expeditiously because we will obtain lower ton costs and better recoveries. This subject is receiving serious consideration.

From the Shattuck property [2] 94,092 dry tons of copper ore were shipped to the smelter at Douglas, where bullion was recovered containing 1,220 ounces of gold, 161,230 ounces of silver, and 9,081,959 pounds of copper. Operation of the concentration mill using oil flotation began July 1, 1918, and 27,851 wet tons of low-grade lead ore were treated, yielding 3,930 tons of concentrate, shipped to El Paso, containing 709 ounces of gold, 66,592 ounces of silver, and 1,907,426 pounds of lead. Some carbonate lead ore was also shipped direct to the smelter at El Paso for treatment. The company's report contains the following paragraphs:

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[1] Calumet & Arizona Mining Co. Ann. Rept. for year ending Dec. 31, 1918.
[2] Shattuck-Arizona Copper Co. Ann. Rept. for year ending Dec. 31, 1918.

> The total amount of new development work done during the year was about the same as during 1917 but without favorable results in the development of commercial copper ores. Between the 800 and 900 foot levels a large body of primary sulphides, high in iron and sulphur, assaying approximately 2 per cent copper, was exposed and a further development of this area is being prosecuted as the year closes with good prospects of opening out sulphide ores assaying more than 4 per cent copper. * * *
>
> Development work in the lead-bearing section of the mine developed good tonnages of milling ore, assaying 6 per cent lead, 8 ounces silver, and $1.20 per ton in gold. Loss of silver in the milling operations has been excessive and every effort is being made to recover these losses. The milling plant is complete, although minor changes must be made to obtain maximum efficiency.

COCONINO COUNTY.

Francis district.—Copper ore from the Emerald, H. P., and Royal properties was shipped directly to the smelters in 1918.

Grand Canyon district.—From the Grand Canyon copper property one carload of copper ore, containing a little silver, was shipped.

GILA COUNTY.

Mine production in Gila County, Ariz., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917..................	50	6,049,544	$126,832	501,920	175,383,626	187,215	35,333	$48,439,848
1918..................	45	7,807,714	137,641	477,041	207,643,252	51,805	....	51,906,243
Increase or decrease	....	+1,758,170	+10,809	−24,879	+32,259,626	−135,410	−35,333	+3,466,395

The total average value per ton of the ore sold or treated in Gila County decreased from $8.01 in 1917, to $6.65 in 1918, and the gold and silver value from 9 cents to 8 cents a ton. The output of gold, valued at $126,832 in 1917, increased to $137,641 in 1918; silver increased in value from $413,582 to $477,041; and copper from $47,879,730 to $51,287,883; but lead decreased from $16,100 to $3,678. There was no production of zinc in 1918. Of the ores produced, 7,470,382 tons were of concentrating grade and produced 320,490 tons of concentrate, containing 3,644 ounces of gold, 244,529 ounces of silver, and 173,897,683 pounds of copper. The crude ores, mostly copper ore, shipped directly to the smelters amounted to 337,309 tons, against 318,539 tons in 1917. The crude ores in 1918, contained 3,009.01 ounces of gold, 232,301 ounces of silver, 33,745,569 pounds of copper, and 51,805 pounds of lead. All of the ore produced was treated in the district, with the exception of lead ores and some copper ores, which were shipped to plants outside of the county. Of the copper ores smelted, 232,338 tons were oxidized and 104,801 tons were sulphides. The smelting ores shipped were valued at $8,633,336, or an average value per ton of $25.59, and the concentrates, chiefly copper, were valued at $43,272,585, or an average value per ton of $135.02.

Banner district.—Five producers shipped 96,941 tons of ore containing $14,173 in gold, 27,707 ounces of silver, 5,830,493 pounds of copper, and 36,235 pounds of lead, valued in all at $1,484,585, or an average value per ton of $15.31. Most of this ore came from the Christmas mine, and a considerable output was reported from the London property. There was some copper ore produced from the Snyder Gulch property, and a shipment from the Apex claim consisted of lead ore, containing considerable gold.

Globe-Miami district.—Thirty-six producers mined 7,710,708 tons of ore, the largest part of this tonnage coming from three properties—the Inspiration, Miami, and Old Dominion. The total ore produced contained $123,330 in gold, 447,395 ounces of silver, 201,806,396 pounds of copper, and 15,570 pounds of lead, valued in all at $50,418,010, or an average value per ton of $6.54. The bulk of the ore was concentrated and produced 320,490 tons of copper concentrate, and 240,324 tons of copper ore, containing silver, were directly smelted. There were only two lots of ore containing lead, which were shipped to the smelter at El Paso, Tex.

From the mines of the Old Dominion Co.[1] 230,451 dry tons of ore were mined, averaging 4.52 per cent of copper. Included in this tonnage were 72,588 tons of smelting ore, averaging 6.54 per cent of copper; 153,166 tons of concentrating ore, averaging 3.59 per cent of copper; and 4,697 tons of siliceous ore, averaging 3.76 per cent of copper, which was used for converter lining. The total production of metal in 1918, including that from custom ores, was 33,378,158 pounds of refined copper, 184,982 ounces of silver, and 5,071.28 ounces of gold. Of this copper only 21,896,780 pounds were sold at an average price of 25.01 cents a pound. Dividends have been paid since 1905 by the companies operating these properties amounting to $14,405,260, of which $1,188,284 was paid in 1918. The company report gives the production of the year as follows:

> The production of copper from direct smelting ores has decreased very seriously during the last two years, due, to large extent, to the disappointing developments in the smelting-ore zone between the eighteenth and sixteenth levels west. Not only has the tonnage of smelting ore developed in that period been small, but the copper content of the ore has been below the average of that mined on the west side of the mine during the past six years. Of this much reduced smelting ore production in 1918 the greater part came from the fifteenth, sixteenth, and eighteenth levels west. A small amount of ore was mined on the ninth, tenth, eleventh, and twelfth levels, a small tonnage came from the fourteenth level, and practically nothing from the seventeenth level west.
>
> As during the past few years, the tonnage of ore obtained from stopes in the center ore body has been comparatively small.
>
> The east side ore body produced most of the concentrating ore for the year. Only a small amount of ore was produced above the twelfth level. * * * The fourteenth level produced 20,000 tons. * * * The fifteenth level was a small producer from stopes in small ore bodies. * * * The sixteenth level gave the largest ore production from any one level. * * * The seventeenth level east also produced a satisfactory tonnage of ore, practically all of which was of smelting grade. * * * This ore is of good grade, the vein is wide, and occurrence fairly regular, so that it has been possible to work out a systematic method of mining and handling which has resulted in excellent mining costs. * * * Only one stope was operated on the eighteenth level east during the year, but development work in drifts, crosscuts, and raises from blocks 27 to 32 produced considerable ore.

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[1] Old Dominion Co. Ann. Rept. for year ending Dec. 31, 1918.

In the Grey mine the sorting over of ore stope filling resulted in a small production of ore, but the possibilities in this direction have been pretty well exhausted.

No leasing was done underground during the year, but approximately 4,500 tons of oxide ore were produced by surface leasers.

There were 5,139,132 tons of ore mined from the Inspiration property[1] in 1918. Of the total ore mined, 5,110,101 tons were treated at the concentrator and 29,031 tons of siliceous oxide ore were shipped to the smelter. The total refined copper returnable from this ore was 98,540,041 pounds. At the concentrator an average of 14,172 tons of ore per day were treated. The ratio of concentration was 32.5 tons of ore into one of concentrate. The concentrate from the tables assayed 16.31 per cent of copper and the flotation concentrate 35.26 per cent of copper. The cost of copper derived from ores treated was 11.259 cents a pound, exclusive of depreciation and Federal income tax. Dividends paid in 1918 amounted to $9,455,736. The company's annual report says:

> The concentrating ores extracted came from the Inspiration division of the property. A small tonnage of siliceous oxidized ore from the Live Oak division and from the old workings of the Keystone property was mined and shipped direct to the smelter. * * *
>
> No development work for the purpose of increasing ore reserves was performed during the war.
>
> The average output of ore per man shift for all the labor chargeable to the mining department was 21.5 tons.
>
> The area covered by the undercutting was 6.78 acres.
>
> A total of 14.88 miles of underground openings were driven, making a total of 127.85 miles; 10.01 miles of such work were destroyed in the process of mining during the year. * * *
>
> The concentrator operated an average of 15 sections during the year, treating 5,110,010 dry tons of ore containing 1.36 per cent copper. The yield of copper from the concentrating ores was 19.08 pounds per ton. * * *
>
> Construction was begun upon an experimental leaching plant designed to have a capacity of 35 tons of oxidized ore daily. This plant will soon be in operation.

In 1918 the Miami mine[2] produced from 2,132,941 tons of ore (averaging 2.026 per cent of copper) 76,750 tons of concentrate (averaging 40.147 per cent of copper), which contained 61,481,662 pounds of copper and yielded 58,407,563 pounds of refined copper. The total cost of handling the ore in 1918 was $2.417 a ton, divided into mining, $1.36; milling, $0.722; and general expenses, $0.334; or a total average per pound of copper of $0.088. With Federal taxes and other costs the average cost of producing copper was 14.833 cents a pound. The total dividends paid by this company since 1912 amounted to $19,595,043.75, of which $3,362,013 was paid in 1918. The company's annual report gives the following:

> During the year it was decided to sink the new No. 5 shaft further than originally figured on. The shaft will therefore be carried to a depth of 930 feet, which will provide a haulage level and ore pocket for the deepest ore at present known to exist on the property, and will allow sufficient depth below this point for the resumption of sinking operations should this be required in the future. During the year this shaft was advanced 882 feet to a total depth of 908 feet and the concrete for a depth of 670 feet was completed.
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> * * *
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> Work on the new test plant for investigating the treatment of oxidized ores was delayed, and in its initial operation certain changes were indicated. These

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[1] Inspiration Consolidated Copper Co. Ann. Rept. for year ending Dec. 31, 1918.

[2] Miami Copper Co. Ann. Rept. for year ending Dec. 31, 1918.

have been completed and the plant has been in operation for a short time with encouraging though not yet definite results. * * *

Ore reserve calculations were carefully checked at the end of the year, allowance being made for any tonnage lost in mining operations up to that date and the remaining high-grade ore available for extraction amounts to 12,570,000 tons. Based on underground sampling, the average grade of this ore is 2.38 per cent copper.

In the low-grade area churn drilling was continued, during the year 13 new holes being completed with a total advance of 9,010 feet. A calculation of the reserves of this class of ore gives a total of 36,000,000 tons of an average grade by drill sampling of 1.06 per cent copper. * * *

The result of the year's operations has been satisfactory and both mine and mill are in position to continue production at the rate reached during the period. At the end of the year about 45 per cent of the original high-grade reserves of the property had been extracted. Up to date, however, mining has included a very considerable proportion of the lower-grade ore from the Captain ore body, which was also high in oxidized copper content. The remaining tonnage is much cleaner in this respect and for this reason and on account of its higher grade, a greater production of copper from the same tonnage can be looked for. During the next few years it is reasonable to expect that possibilities of profit will be demonstrated from the handling of both the oxidized and low-grade ores existing in the property.

The Arizona Commercial mine[1] produced 62,797 tons of ore, which included 18 tons of smelter cleanings, 11,712 tons of crude smelting ore, averaging 10.27 per cent of copper; 51,053 tons of concentrating ore, averaging 4.86 per cent of copper; and 13 tons of lease ore, averaging 5.62 per cent of copper. These products were shipped to the Old Dominion concentrator and smelter. The total output was 6,076,303 pounds of copper, 15,980.67 ounces of silver, and 830.52 ounces of gold. Dividends amounting to $1,086,500 have been paid since October 31, 1916, and include $530,000 paid in 1918. According to the company's annual report the greater part of the ore produced in 1918 was mined from that part of the property east of the Budget fault, where extensive development work was performed. The company report says:

On the fifteenth level also a very gratifying discovery of new ore has been made. The main footwall drift has been extended east 140 feet into block 76, and three crosscuts driven through the vein in blocks 74, 75, and 76, opening up 200 feet of ore from 5 to 20 feet in width. The block 75 crosscut went through 15 feet of 12 per cent ore. Raises have been put through to the fourteenth level, but stoping will probably not be started until the considerable amount of water coming from the vein has drained. On the sixteenth level 43 feet of station has been cut. * * *

The total amount of water pumped from the mine during the year was 311 million gallons, as compared with 367 million gallons pumped during 1917. The maximum rate of flow was 1,202,500 gallons per 24 hours, reached on November 1, and the minimum was 692,500 gallons per 24 hours, reached on October 13. A sump has been cut on the sixteenth level and the 500-gallon Aldrich pump formerly used on the fourteenth level has been installed.

The Superior & Boston property[2] produced during the fiscal year 22,751 tons of ore, assaying 3.88 per cent of copper and 0.4 ounce of silver per ton, on which the company's estimates show a profit of $1.03 per ton. The principal operations consisted of development work in the east end of the mine on the 800 and 1,000 foot levels, and also in reopening the 1,200-foot level for development.

There were shipped in 1918 from the Iron Cap property[3] 57,291 tons of smelting ore and 27,399 tons of concentrating ore, from both of which 153,585 ounces of silver and 9,441,000 pounds of copper were recovered. The Williams shaft has been sunk to the 1,200-foot level, where a station has been put in. During the month of November connection was made with the Iron Cap shaft. This shaft was sunk 111 feet in 1918, making a total depth of 1,126 feet.

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[1] Arizona Commercial Mining Co. Ann. Rept., for year ending Dec. 31, 1918.
[2] Superior & Boston Copper Co. Ann. Rept. for year ending Sept. 30, 1918.
[3] Iron Cap Copper Co. Ann. Rept. for year ending Dec. 31, 1918.

The International smelting plant[1] at Miami treated 332,644 tons of copper concentrates and 45,290 tons of purchased ores, a total of 377,935 tons, from which there were produced 173,043,136 pounds of fine copper, 252,437.47 ounces of silver, and 4,255.80 ounces of gold.

Green Valley district.—A small quantity of gold bullion was reported as having been produced in the district, probably from former operations.

Mazatzal district.—A small lot of copper ore, containing silver and gold, was shipped to the smelter from one property in the district.

Richmond Basin district.—The Gila Monster Co. operated some of the old silver mines and produced a small quantity of silver bullion in a 10-stamp mill, which was completed late in 1918.

GRAHAM COUNTY.

Seven producers in Graham County in 1918 reported 1,625 tons of ore, containing gold, silver, copper, and lead, valued at $136,969. All of this ore was of shipping grade and was produced principally in the Aravaipa district.

Aravaipa district.—Four producers shipped 1,294 tons of ore, containing $137 in gold, 27,995 ounces of silver, 65,905 pounds of copper, and 1,174,860 pounds of lead, valued in all at $127,825, or an average value per ton of $98.78. The largest part of the output came from the Grand Reef property of the Laurel Canyon Leasing Co. There were smaller shipments from the Imperial group and other properties.

Bunker Hill district.—A small output of copper ore, containing silver, was shipped from the district in 1918. Most of it was reported from the Concordia mine, situated on Copper Creek.

Lone Star district.—The San Juan claim produced copper ore containing a little silver. This ore was shipped to the smelters at Douglas and El Paso.

Stanley Butte district.—From the Copper Bell and Friend claims a small quantity of ore was shipped to the El Paso smelter.

GREENLEE COUNTY.

Mine production in Greenlee County, Ariz., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	17	1,431,118	$52,734	83,458	53,072,330		$14,610,249
1918	23	2,102,725	79,438	142,399	71,868,688	10,026	17.974,115
Increase		671,607	26,704	58,941	18,796,358	10,026	3,363,866

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[1] Anaconda Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

Twenty-two producers of ore in Greenlee County in 1918 mined 2,102,725 tons—671,607 tons more than was reported by 17 deep-mine producers in 1917. The ore sold or treated averaged $8.55 a ton in 1918, against $10.21 in 1917. The gold and silver reported from the refining of copper bullion amounted to only 11 cents a ton. The concentrating ores aggregated 1,836,584 tons and produced 229,679 tons of concentrates, which contained $52,403 in gold, 79,789 ounces of silver, and 54,204,553 pounds of copper, valued in all at $13,520,716, or an average value per ton of $58.87. The ore smelted (216,369 tons) was mostly copper ore, of which 163,450 tons were classed as oxidized ore and 52,283 tons as sulphide. Only a small quantity of placer gold was reported in 1918.

Ashpeak district.—Three producers reported the output of 421 tons of ore, containing $500 in gold, 6,283 ounces of silver, 1,443 pounds of copper, and 10,026 pounds of lead, valued in all at $7,851, or an average value per ton of $18.65. All of the ore was shipped directly to the smelters and came principally from the Ashpeak property and its extension.

Copper Mountain and Greenlee districts.—The combined output of these two districts represents practically all of the production of Greenlee County shown in the table above. Placer gold sold to buyers in the district was reported to have been produced from the San Francisco River gravels.

The Detroit mine[1] produced 480,405 tons of concentrating ore, assaying 1.91 per cent of copper, which yielded 1.356 per cent of fine copper. There were 24,210 tons of smelting ore treated assaying 8.76 per cent of copper, from which was recovered 8.338 per cent of fine copper. From this output, 1,444 tons of old slag and tailing, and 5,867 tons of siliceous ore to converters, there were produced altogether 17,127,369 pounds of fine copper. A distribution of the tonnage of ore from the various mines into different classes is taken from the annual report of the Phelps Dodge Corporation as follows:

Mine.	Total.	Second class.	Belt sulphide.	Copper Mountain sulphide.	First class.	Cleanings.	Quartz.	Precipitates.
Ryerson	201,150	198,297	493		2,346	8.2		4.7
Yankie	90,672	86,619	1,131		7		2,871	43.7
Copper Mountain	51,847	44,159	243	7,446				
Arizona Central	122,138	121,397	710			30.7		
	465,807	450,472	2,577	7,446	2,353	38.9	2,871	48.4

From the annual report[2] of the Arizona Copper Co. the following paragraphs are taken:

> During the year our production of copper was 40,442,000 pounds, which compares with 42,482,000 pounds for the previous year.
>
> The total ore mined from the company's properties amounted to 1,095,568 tons, as compared with 1,178,087 tons in the previous year, and the yield, as indicated by the smelter returns from ores treated, was 35.08 pounds of copper per ton of ore, which compared with a yield of 36.6 pounds per ton treated during the previous year. * * *

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[1] Phelps Dodge Corporation Ann. Rept. for year ending Dec. 31, 1918.

[2] Arizona Copper Co. Ann. Rept. for year ending Sept. 30, 1918.

The cost of all important supplies has steadily increased during the war, until double and even treble their normal prices have had to be paid for commodities entering largely into the production of copper, resulting in exceedingly high operating costs, which have been aggravated by inefficiency due to scarcity of labor. * * *

The daily output of ores from the mines was 3,320 tons, as compared with 4,808 tons in the previous year, the lower tonnage being due to the strike, the shutting down of the Clifton concentrator to allow of certain changes being made, and the shortage of labor, especially miners and timbermen.

The grade of smelting ore treated was 6.38 per cent copper, and the grade of concentrating ore treated was 2.338 per cent.

While development work was seriously curtailed during the year, additional ore was added to our reserves in the King, Coronado, and Pyramid mines of similar grade to that which we are milling to-day, viz, about 2 per cent, and in quantity slightly in excess of tonnage extracted, and it should be noted that as the new ore developed from year to year drops in grade, the conservative policy of lowering the grade of the ore delivered to the concentrators has been pursued, thus conserving the life of the mines.

Prospecting with churn drills has been begun, to determine the character of the ground lying east of the Coronado adit. During the year some 6,000 feet have been drilled, the holes being put down to a depth of 700 to 1,000 feet, but the mineral found is finely disseminated primary pyrites containing too small a percentage of copper to be considered of value. * * *

Owing to the Government's requirements for manganese for war materials, [and] the scarcity and high price of this material, it was decided to develop the company's deposit located a mile up the river from Clifton. With a view to determining its value, some 1,311 feet of tunnels and raises were driven, which proved up, approximately, 48,000 tons of 12 per cent ore, which is too low for profitable extraction by methods available at present, and further work was suspended.

The total ore treated by concentrators during the year was 1,049,118 dry tons.

No. 6 concentrator, at Morenci, treated 935,861 dry tons of an average grade of 2.36 per cent copper, of which 0.35 per cent was in oxidized form.

A total extraction of 71.63 per cent was made. * * *

No. 4 concentrator at Clifton, treated 113,257 dry tons during the period. The average grade of this ore was 2.13 per cent copper, of which 0.49 was oxide, and the extraction was 71.25 per cent. * * *

The total amount of new material smelted during the year was 216,336 dry tons, and the average per working day 600 tons; two furnaces were in operation 184 days, and one furnace 177 days, giving an average of 390 tons per furnace per day.

MARICOPA COUNTY.

The output of 317 tons of ore in Maricopa County in 1918, reported by 7 producers, was 1,235 tons less than was reported by 14 producers in 1917. The total average value per ton increased from $36.91 in 1917 to $51.28 in 1918, and the gold and silver value of this ore decreased from $20.06 to $9.62. The milling ores producing gold and silver bullion aggregated 30 tons, a decrease from 428 tons in 1917. The higher average value was due to shipments of picked ore (287 tons) selected to bear the cost of treatment and transportation to the smelter. The total value of all the ore milled and shipped amounted to $16,256, a decrease of $41,026 from 1917. No placer gold was reported.

Moore district.—The Orizaba property produced a small lot of sulphide copper ore, containing a little silver and gold. This ore was shipped to the Hayden smelter in 1918.

Sunset district.—Two producers reported the shipment of copper ore, containing considerable gold and a little silver.

Vulture district.—The clean-up of the Vulture mill by a lessee, who shipped some mill bullion and other material, represented the largest part of the production of the district in 1918. The mine and mill of the Vulture Co. were closed in 1917.

White Picacho district.—Copper ore from the Orion property represented the only production of the district in 1918.

Other districts.—The Rowley Copper Co., near Gila Bend, shipped lead ore, containing silver, to El Paso, Tex., and sold a quantity of ore containing molybdate of lead to ore purchasers at Tucson.

MOHAVE COUNTY.

Mine production in Mohave County, Ariz., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	59	275,565	$2,463,178	370,094	897,973	6,141,246	17,149,200	$5,290,649
1918	60	192,585	2,798,903	114,707	528,346	587,814	82,853	3,093,386
Increase or decrease		−82,980	+335,725	−255,387	−369,627	−5,553,432	−17,066,347	−2,197,263

The total average value per ton of the ore produced by 60 operators in Mohave County decreased from $19.20 to $16.07, but the gold and silver value increased from $10.05 to $15.13 per ton. The total gold increased in value from $2,463,178 in 1917, to $2,798,903 in 1918; but the value of silver decreased from $304,958 to $114,707; the lead from $528,147 to $41,735; the copper from $245,147 to $130,501; and the zinc from $1,749,219 to $7,540. Most of the ore produced in the county is of milling grade and yields bullion or concentrates. There were 183,244 tons of ore treated by amalgamation or cyanidation, which produced $2,778,459 in gold and 71,440 ounces of silver having a total value of $2,849,899, or an average value per ton of $15.55. The concentrating ores aggregated 4,670 tons and produced 272 tons of concentrates against 76,397 tons of ore and 33,801 tons of concentrates in 1917. The concentrates in 1918 contained $482 in gold, 4,030 ounces of silver, 37,520 pounds of copper, and 9,657 pounds of lead, having a total value of $14,465, or an average value per ton of $53.18. Crude ore shipped to smelters amounted to 3,455 tons, against 5,395 tons in 1917. In 1918 shipping ore contained $19,963 in gold, 39,237 ounces of silver, 435,434 pounds of copper, 578,157 pounds of lead, and 82,853 pounds of zinc, and had a total value of $215,341, or an average value per ton of $62.33.

Bentley district.—The Grand Gulch, Savanic, and Copper Mountain properties produced considerable oxidized copper ore, which was shipped to a smelter near Salt Lake.

Cedar Valley district.—The principal part of the production of the district in 1918 came from the Leviathan property and consisted of shipments of concentrate containing about 15 per cent of molybdenite and the same quantity of copper. The product was shipped to the company's works at Los Angeles for the manufacture of molybdic acid, ferromolybdenum, ammonium molybdate, and other compounds. At the mine the ore is treated in a mill equipped with crusher, tube mill, and flotation cells sufficient to handle 75 tons of ore a day.

Chemehuevis district.—A small quantity of ore was treated by amalgamation from the Dutch Flat property, resulting in the shipment of some gold bullion.

Gold Basin district.—Operations at the Cyclopic mine and mill in 1918 resulted in the shipment of a small quantity of gold precipitate.

Greenwood district.—From the McCracken property a small lot of lead sulphide ore, containing silver, was shipped to the smelter. A mill having a daily capacity of 100 tons was lately constructed near the mines. It is operated by a large semi-Diesel engine, and the ore is put through a crusher and then through coarse and finishing rolls, the pulp going to Stebbins dry concentrating tables.

Lost Basin district.—During the operation of the Vindicator property in 1918 a small lot of sulphide copper ore was mined and shipped to the smelter by lessees. The property was subsequently turned back to its owners, as the lessees failed to exercise the option.

San Francisco district.—From the reports of 11 mines operators there was an output of 182,824 tons of ore, which came principally from two properties equipped with cyanidation plants. The production was gold and silver bullion, which contained $2,772,991 in gold and 70,432 ounces of silver, valued in all at $2,843,423, or an average value per ton of $15.55. The important producers were the United Eastern, Tom Reed, Gold Ore, New Philadelphia, Orphan, and Pioneer mines.

In 1918 the United Eastern mine[1] produced and the mill treated 92,339 tons of ore, averaging in value $23.16 a ton, against 84,548 tons of ore treated in 1917, averaging $22.42 a ton. There were recovered in 1918, 97,827,459 ounces of gold, valued at $2,022,267.95, and 52,485.38 ounces of silver, valued at $50,090.84, or a total value of $2,072,358.79. The tailing from the ore treated contained 3,075.62 ounces of gold, valued at $63,578.62, and 1,652.46 ounces of silver, valued at $1,580.36, making a total loss of $65,158.98, or $0.706 a ton. The total value of the gold and silver contained in the ore was $2,138,417.27, and the total loss of the two metals was $65,158.98, leaving the total amount recovered $2,073,258.29, or $22.45 a ton of ore treated. Dividends paid in 1918 amounted to $845,060, making a total of $1,253,960, which has been paid to stockholders beginning in 1917. From the company's annual report the following is taken:

> There was no change of importance in the method of mining. The cut-and-fill method continues to work satisfactorily. All waste broken in development is used for stope-filling, and the additional waste required is broken in a waste stope started for that purpose. The waste stope is now furnishing filling at a lower cost than it can be produced from raises in the walls, and it is expected that by making the excavation sufficiently large a cave will be started from which filling can be drawn at a very low cost. The use of inclined raises in the footwall and hanging wall of the stopes will not be entirely done away with, as they serve the very useful purpose of prospecting the walls, and thereby eliminate the possibility of overlooking ore lying near the main ore body.
>
> In the wider parts of the stopes filling is now distributed by dumping it from the level above into the stope through a central raise with a chute, from which it is drawn into a mine car and trammed to the required point.
>
> The work of sinking the main shaft, which was under way at the close of 1917, was stopped in January, 1918, at the total depth of 1,176.5 feet. The

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[1] United Eastern Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

> seventh and eighth levels, which are respectively 150 feet and 300 feet below the 665-foot level, were opened. * * *
>
> The operation of the mill has been most satisfactory. An average of 253 tons per day was maintained in spite of the fact that several months were much below the normal on account of power troubles, repairs, and the influenza epidemic. The rate of recovery was 96.95 per cent, an increase of 0.62 of 1 per cent over the previous year. * * *
>
> Mining costs were higher by 59 cents per ton for 1918 than for the year previous. This was caused by increases in the prices of power, labor, and supplies, amounting to 28 cents per ton, and by the increased amount of development work done, which cost 50 cents per ton in excess of the previous year. The item of decreased labor efficiency had a marked effect on the costs, but it is difficult to give an accurate estimate of its importance in dollars and cents.
>
> The increase in milling costs of 5 cents per ton is more than accounted for by the increase in cost of labor and power, amounting to 8 cents per ton.
>
> In indirect costs, the largest increase was in State taxes, which now amount to 69 cents per ton, an increase of 50 cents above last year's figure.

The Tom Reed mine[1] produced ore which was treated by cyanidation and resulted in bullion containing gold and silver valued at $794,383.20, or an average of $9 a ton of ore. The loss of gold and silver in the tailing was reported to be 37 cents a ton. With mining cost at $3.21 a ton, milling cost at $2.09 a ton, and administration expenses at 27 cents a ton, the total cost per ton was $5.58, which leaves a profit of $3.42 a ton of ore treated. The company report says:

> In the mining operations for the year a total of 63,974 tons of ore were broken and 8,006 tons of waste rock, the latter being used as stope filling. We begin the new year with proven ore reserves, broken and unbroken, of 65,800 tons. * * *
>
> During the year ending March 31, 1919, there were reduced and treated 88,312 tons of ore from the mines and 213 tons of tailing scrapings.

Wallapai district.—For many years the Wallapai district has been a producer of a considerable output of ore of milling and shipping grade. The output in 1917 was 104,362 tons of ore, compared with 4,739 tons in 1918. This output included 2,018 tons of ore shipped directly to smelters. The shipping ore contained 963.93 ounces of gold, 38,332 ounces of silver, 27,738 pounds of copper, 523,805 pounds of lead, and 82,853 pounds of zinc, valued in all at $116,346, or an average of $57.65 a ton. At concentration mills there were 1,699 tons of ore treated, yielding 166 tons of concentrate containing lead, silver, and copper. Leaching operations were continued on the copper ore at the Emerald Isle property, and copper precipitate was shipped.

PIMA COUNTY.

Mine production in Pima County, Ariz., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	64	995,909	$7,553	167,634	34,877,443	687,019	194,611	9,746,159
1918	56	2,033,450	1,359	128,399	60,024,129	368,172	540,027	15,031,000
Increase or decrease		+1,037,541	−6,194	−39,235	+25,146,686	−318,847	+345,416	+5,284,841

[a] Includes placer production.

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[1] Tom Reed Gold Mines Co. Eleventh Ann. Rept., for year ending Apr. 1, 1919.

The total average value per ton of the ore produced by 54 mine operators in Pima County decreased from $9.78 in 1917 to $7.39 in 1918, and the gold and silver produced from the smaller shipments made the total tons of ore mined average 6 cents in gold and silver, against 14 cents in 1917. The total gold decreased in value from $7,553 in 1917 to $1,359 in 1918; the silver from $138,130 to $128,399; and the lead from $59,084 to $26,140. The value of copper increased from $9,521,542 in 1917 to $14,825,960 in 1918, and that of zinc from $19,850 to $49,142. The most notable increase was in the output of copper from the low-grade disseminated ores produced in the Ajo district.

Ajo district.—The largest part of the district output of ore was produced from the New Cornelia mine.[1] At the leaching plant of the company 1,775,000 tons of ore were treated, averaging 1.46 per cent of copper, and 84,161 tons of first-class ore, containing an average of 3.39 per cent of copper, were shipped to the smelter at Douglas. The ores contained altogether 46,950,139 pounds of copper, divided as follows: 31,264,642 pounds in electrolytic copper, 10,990,666 pounds in cement copper shipped, and 4,694,831 pounds in ore treated at the smelter. The year 1918 marks the first full year of the company as a producer of copper on a large scale. The company's report gives further details, some of which follow:

> Toward the end of the year a small amount of diamond drilling was authorized just to the southwest of the developed ore body to determine the proper limit for stripping in the open-pit work, and this development work has already opened up about a million tons of additional sulphide ore. As mentioned in my previous report, a number of diamond drill holes in the main ore body were bottomed in ore, and there are undoubtedly notable amounts of ore under the developed ore which as yet can not be measured until further development is done. * * *
>
> The production of cement copper is about one-third as much as the electrolytic copper produced. It was hoped that more electrolytic and less cement copper could be made, but it has been found better to make a little more of the latter than to run the risk of oversaturating the solutions, with a resulting reduction in the percentage of extraction.
>
> The recoveries for the year have been very satisfactory, and I believe that we can safely say that future recoveries will be fully as high and should be even higher. * * *
>
> In the course of two years sulphide ores will be uncovered in the open pit. In about three years the mine can produce as much as 5,000 tons a day of this class of ore, and after that the output should rapidly increase until a capacity of 10,000 tons a day of sulphides can be produced. The question of the proper way to treat this ore is most important. In spite of the high cost of material, therefore, an appropriation was obtained from the board (of $160,000) for the construction of a test mill.

Amole district.—Copper ore and some lead ore, carrying silver, the output of four producers, aggregating 584 tons, was shipped in 1918 having a total value of $17,222, or an average value per ton of $29.49. The Copper King and Saginaw properties were the most important mines producing.

Arivaca district.—A small quantity of lead ore was produced and shipped from the Fairview claims.

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[1] New Cornelia Copper Co. Ann. Rept. for year ending Dec. 31, 1918.

Baboquivari district.—From the Gold Bullion claim some siliceous gold and silver ore containing a little copper, the output of a lessee, was shipped to the smelter.

Cababi district.—The Bonnie Bell property, near Indian Oasis, produced a small quantity of copper-lead ore, which was shipped to the El Paso smelter. There was also a small shipment of copper ore from the Cababi claims.

Empire district.—From four properties 469 tons of ore were shipped, containing $64 in gold, 2,725 ounces of silver, 1,371 pounds of copper, 165,093 pounds of lead, and 50,864 pounds of zinc, valued in all at $19,478, or an average value per ton of $41.53. The largest producer in the district was the Total Wreck mine, which produced ore containing the mineral from which both lead and molybdenum were recovered. The other producers were the Forty-Nine claim, producing oxidized lead ore containing silver; the Jerome No. 2, producing oxidized zinc ore, which was shipped to a zinc reduction plant in New Mexico; and the Verde Queen claim, a producer of lead-silver ore.

Greaterville district.—Owing to the transitory character of the placer operators of this district, only a very small quantity of the gold actually produced is reported. In 1918 only $416 in gold and silver was known to have been produced. New developments are in progress on lode claims in the district, chiefly at the St. Louis mine.

Helvetia district.—Eight producers reported the output of 16,302 tons of ore, containing $56 in gold, 17,828 ounces of silver, 2,156,486 pounds of copper, 12,406 pounds of lead, and 489,163 pounds of zinc, valued in all at $595,931, or an average value per ton of $36.56. All this ore was of shipping grade and most of it was produced from the Narragansett property. Smaller shipments were made from the Rosemont, Sweet Bye and Bye, and Copper Duke claims.

Myers district.—Some lead ore was shipped from the Gunsight property in 1918.

Papago district.—Some copper ore was shipped to Douglas from the Providence claims in 1918.

Pima district.—The reports of 22 producers show an output of 27,533 tons of ore, containing $159 in gold, 55,154 ounces of silver, 3,032,095 pounds of copper, and 114,622 pounds of lead, valued in all at $812,379, or an average value per ton of $29.51. All the ore produced was of shipping grade, the principal part of it coming from the Glance mine, with shipments also from the Copper Queen, Mineral Hill, Plumed Knight, and San Xavier Extension properties. Shipments were also reported from the Gray Copper, Alpha, Senator Morgan, Silver Helmet, and Vulcan claims.

Santa Rosa district.—A small quantity of lead ore, carrying silver, was reported from one claim.

Silver Bell district.—The total output of the district, reported by six operators, aggregated 129,314 tons, mostly copper ore from the Imperial property, which was treated at the Sasco smelter. Shipments were also made from the El Tiro and Young America properties. All the ore was of smelting grade and had a reported value of $1,983,990, or an average value per ton of $15.34.

PINAL COUNTY.

Mine production in Pinal County, Ariz., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	26	3,798,731	$163,559	679,939	102,912,392	925,481	11,322	$28,899,658
1918	34	3,637,119	[a]154,627	[a]690,687	98,598,140	3,854,756	....	25,472,743
Increase or decrease	......	−161,612	−8,932	+10,748	−4,314,252	+2,929,275	−11,322	−3,426,915

[a] Includes placer production.

Thirty-three mine operators in Pinal County produced 3,637,119 tons of ore, the principal part of which was from the Ray mines. The output of ore was less by 161,612 tons than the production of 26 operators in 1917. The total average value per ton decreased from $7.61 in 1917 to $7 in 1918, but the gold and silver in this ore increased from 19 cents to 23 cents a ton. Nearly all of the ore or 3,555,715 tons, was of concentrating grade and produced 259,337 tons of concentrate, most of which contained copper, there being only a small quantity of lead concentrate recovered at one property. The ores of smelting grade, shipped directly to smelters, aggregated 81,404 tons and contained 2,131.39 ounces of gold, 279,576 ounces of silver, 10,909,117 pounds of copper, and 3,347,587 pounds of lead, valued in all at $3,255,866, or an average value per ton of $40. In 1917 the shipments of ore aggregated 108,854 tons, valued at $3,535,391, or an average value per ton of $32.48. A small quantity of placer bullion was reported in 1918.

Bunker Hill district.—Four producers reported 671 tons of ore, containing $127 in gold, 2,228 ounces of silver, 97,887 pounds of copper, and 46,012 pounds of lead, valued in all at $29,800, or an average value per ton of $44.41. Most of the ore produced was of concentrating grade, yielding copper concentrate, and the remainder, 71 tons, containing lead and copper, was shipped directly to the smelter. The producers were the Copper State, Bunker Hill, Thornwood, and Sunset properties.

Casa Grande district.—Three producers reported 47 tons of ore, containing gold, silver, copper, and lead, having an average value per ton of $36.45. The producers were the Broken Hill, Ramona, and Red Chief properties.

Florence district.—This district is situated 7 miles west of Florence and 1 mile north of Walker Peak. One producer reported the shipment of copper ore said to have come from the Florence group, containing the Mellie, Buckskin, and J. C. T. claims.

Mineral Creek or Ray district.—Most of the ore produced in the district was from the Ray Consolidated property, and outputs were also made from the Ray Hercules, Copper Butte, Ray Silver-Lead, and Rickerson properties. The mill at the Ray Hercules mine was completed and a considerable quantity of low-grade copper ore yielded a good grade of concentrate, which was shipped to the Hayden smelter. The plant has a capacity of 1,500 tons and is equipped for flotation This property is opened by two vertical shafts, 863 and 532 feet, respectively. Shipments of concentrate began in August, 1918.

The Ray Consolidated mine[1] produced 86,919,270 pounds of copper, a net output after smelter deductions were made of 83,599,160 pounds. This makes the total copper production 484,309,560 pounds since production began in April, 1911, to the end of the year, 1918. The annual report contains the following paragraphs:

> The total amount of ore mined, from all sources, during the year, and shipped to the reduction works at Hayden, was 3,476,749 tons, an average of 9,525 tons per day, containing 1.654 per cent copper. This is a decrease from the year 1917, when the production was 3,621,233 tons, or an average of 9,921 per day. Of the ore received at the mill for 1918, 3,426,600 tons, equivalent to 9,388 tons per day, averaging 1.613 per cent copper, was milling ore; the remainder, 50,149 tons, averaging 4.46 per cent copper, was sorted or selected ore, which was diverted to the smelter for direct smelting.
>
> The mining cost for the year was $1.76, of which $0.065 per ton was due to the coarse crushing and loading, leaving the net mining cost $1.695. The ore body tributary to the No. 3 shaft is so located that the regular caving system, in use at the property, can not be applied, and it is necessary to use the square set system of mining, which is more expensive. Eliminating the tonnage so mined, the net mining cost was $1.65. In analyzing this marked increase in mining cost, it is interesting to make comparisons with results obtained in 1914; as compared with that year, the average wage paid in 1918 was about 60 per cent greater. Supply costs increased in even larger percentage, and State, county, and Federal taxes increased 1,133 per cent. * * *
>
> The total ore milled for the year was 3,411,000 dry tons, corresponding to a daily average of 9,345 tons, as compared with 3,560,900 dry tons during 1917. The total amount of the ore milled since the beginning of operations and to the end of 1918 was 20,193,600 tons, averaging 1.667 per cent copper. The average grade of the ore milled for 1918 was 1.613 per cent copper as compared with 1.635 per cent copper for 1917. The average recovery was 74.92 per cent, corresponding to 24.17 pounds of copper per ton, as compared with 74.53 per cent, or 24.37 pounds of copper per ton for the previous year.
>
> The concentrate production for the year was 226,527 tons, containing an average of 18.198 per cent copper. The following is a schedule showing the milling performance for the past four years:

Year.	Tonnage.	Heads, per cent copper.	Per cent recovery.	Copper recovered per ton of ore.
				Pounds.
1918	3,411,000	1.613	74.92	24.17
1917	3,560,900	1.635	74.53	24.37
1916	3,332,340	1.607	70.20	22.56
1915	2,848,969	1.673	64.11	21.45

> The recovery of copper occurring in the form of sulphides was 83.68 per cent while the recovery of the oxides and carbonates of copper, which are not readily amenable to water concentration, was 30.88 per cent, Considerable progress has been made in the development of the process for increasing the extraction of the oxides and carbonates.
>
> The cost of milling for the year was $1.01 per ton as compared with $0.83 for the previous year. This increase in cost was occasioned by the same factors that affected the mining cost, namely, increase in labor, supplies, and taxes. * * *

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[1] Ray Consolidated Copper Co. Tenth Ann. Rept., for year ending Dec. 31, 1918.

The average cost per pound of net copper produced from milling and direct smelting ore for the year was 17.695 cents. This cost does not take into account any credits for the value of the gold or silver, nor for miscellaneous income. By crediting these the cost is reduced to 17.193 cents as compared to 12.446 cents on the same basis for 1917. The cost stated includes all operating and general expenses, together with reserve set aside for the extinguishment of mine development costs, which amounted to 12½ cents per ton for the first six months and 15 cents per ton for the remainder of the year; the advance being made on account of the general increase in development costs. There was a very substantial increase in smelting and refining charges made necessary in order to compensate in part for advances in costs of those operations. Of the above cost per pound of net copper produced 2.6 cents comprise the reserve for payment of State and local taxes, depreciation charges, and an estimate of Federal taxes, the exact amount of the latter being unknown pending a determination of some questions of interpretation of the Federal tax laws as applying to mining properties.

Old Hat district.—The Mammoth mine was the most important producer of ore, which was milled for its wulfenite concentrate, from which molybdenum, lead, and silver were obtained. There was also lead concentrate shipped to the El Paso smelter. A few tons of ore were shipped from the Daily-Arizona mine, and bullion buyers in the district reported the purchase of a small quantity of placer gold.

Pioneer district.—The output of ore reported by 8 producers aggregated 94,781 tons, containing $118,044 in gold, 544,478 ounces of silver, 12,331,613 pounds of copper, and 21,904 pounds of lead, valued in all at $3,709,986, or an average value per ton of $39.14. The principal part of the production was ore of milling grade, of which there were 76,241 tons, yielding 29,599 tons of copper concentrate. Crude ore shipped to smelters aggregated 18,540 tons, containing 1,628.01 ounces of gold, 257,200 ounces of silver, 5,949,938 pounds of copper, and 20,430 pounds of lead. The principal producer of ore was the Magma Copper Co., which treated its ore in a mill equipped for gravity concentration followed by flotation. The average silver content of the Magma ore is high compared with other copper ores.

During the year the Magma mine[1] produced 90,321 tons of ore, of which 15,880 tons was hand-sorted crude sulphide ore. This sorted ore, shipped directly to the smelter, averaged 0.1019 ounce of gold and 13.186 ounces of silver per ton and 16.67 per cent of copper. The milling ore, 74,441 tons in quantity, yielded 29,588 tons of concentrate, containing 0.1379 ounce of gold and 9.413 ounces of silver per ton, and 10.782 per cent of copper. The average assay of the mill tailing was 0.43 ounce of silver per ton and 0.3482 per cent of copper. The company report gives the following:

> The mill recovery was 95.33 per cent of the total copper in the mill heads. The total copper recovered, including ore obtained by hand sorting, was 97.39 per cent of the copper contents of the run-of-mine ore.
>
> The net production, after deducting all smelting and refining losses, was 10,968,556 pounds of copper, 463,503.04 ounces silver, and 5,699.376 ounces gold.
>
> * * *
>
> During 1918 the development work done on the lower levels of the mine has given very satisfactory results.
>
> On the 1,500 and 1,600 levels we followed out the policy outlined in last year's report, which was to extend these two levels to the east as rapidly as possible, in order to prospect the eastern portion of the property. Very little

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[1] Magma Copper Co. Ann. Rept. for year ending Dec. 31, 1918.

crosscutting has been done from these drifts, which are being driven in wall rock, as to do so would interfere with the advance of the main drifts. This policy will be continued for at least another six months, after which we expect to thoroughly crosscut the vein. The east 1,500 level drift passed through the vein approximately 700 feet east of the main crosscut, and is again passing through the vein at the present time approximately 1,400 feet east of the main crosscut. In both places from three to five feet of siliceous vein material, carrying pyrite, some chalcopyrite, and a little bornite has been exposed. Assays of 1½ to 3 per cent copper and 2 to 6 ounces of silver have been secured from these two showings. I believe there is a very good chance of developing commercial ore by driving additional crosscuts into the vein from this drift. This work will be done during the coming year.

The east 1,600 level drift has been driven approximately a thousand feet to the east of the main crosscut in the north wall of the vein. A crosscut was driven to the south, through the vein, 400 feet east of the main crosscut. This work exposed 9½ feet of ore, assaying 5.2 per cent copper, 13.7 ounces silver, and 0.065 ounce gold. Copper values were due to presence of chalcopyrite and bornite. The result was very encouraging, as this ore occurs farther to the east than any other commercial ore found on the lower levels of the mine. There are now 10 crosscuts on the 1,600 level, which indicate an ore shoot 800 feet in length.

Only 80 feet of drifting has been done to date in the vein on the 1,700 level. The average of the samples taken from this drift is 15.3 per cent copper, 7.8 ounces silver, and 0.078 ounce gold. The high copper value is due to the presence of considerable massive bornite. The face of the east drift assays 22.53 per cent copper and the face of the west drift assays 4.67 per cent copper.

On the 1,800 level 7 crosscuts show a length of 500 feet, averaging 9.7 feet in width and assaying 5.35 per cent copper, 3.6 ounces silver, and 0.01 ounce gold. The face of the west drift on this level still assays 7 per cent copper.

There has been practically no change in the character of ore found for the last thousand feet in depth, and as much bornite is still found on the lower levels of the mine as was encountered above.

There were important developments on the Silver King property, which produced milling ore and siliceous silver ore of shipping grade. Shipments of copper ore were made in 1918 from the Superior Arizona, Virginia, Grand Pacific, and Bomboy properties.

Priorwood district.—From the property operated by the Antelope Peak Co. some oxidized copper ore was shipped to the Hayden smelter. This property is opened by a vertical shaft 300 feet deep and has 1,700 feet of drifts.

Riverside district.—A small quantity of copper ore was produced from the property of the Kelvin Development Co.

SANTA CRUZ COUNTY.

Forty-one producers in Santa Cruz County reported 104,195 tons of ore in 1918, or 39,316 tons more than was reported by 26 producers in 1917. In 1918 the ore sold or treated contained $9,252 in gold, 271,197 ounces of silver, 5,367,276 pounds of copper, 1,453,557 pounds of lead, and 1,149,505 pounds of zinc, valued in all at $1,813,974, or an average value per ton of $17.41. The ore produced in 1917 was valued at $1,661,698, or an average value per ton of $25.61. Ore of shipping grade amounted to 43,195 tons and contained $3,456 in gold, 230,798 ounces of silver, 4,109,237 pounds of copper, 326,805 pounds of lead, and 300,212 pounds of zinc, valued in all at $1,299,758, or an average value of $30.09 a ton. At milling plants lead concentrate and zinc concentrate were made aggregating 5,497 tons, containing gold, silver, and copper, valued in all at $511,204, or an average value per ton of $93.

Harshaw district.—Altogether 5,343 tons of ore were mined by 11 operators, who reported $416 in gold, 18,554 ounces of silver, 5,496 pounds of copper, and 386,448 pounds of lead, valued in all at $47,766, or an average value per ton of $8.94. There were 5,000 tons of milling ore which produced lead concentrate containing some silver, and 325 tons of ore, containing 19.50 ounces of gold, 14,568 ounces of silver, 5,137 pounds of copper, and 77,460 pounds of lead, were shipped directly to the smelters. In addition to this output 18 tons of slag were shipped from the old dump of a smelter operated in the early days. The principal milling operations were carried on at the flux property. There was also a milling test made on the manganese ores of the Hardshell property, with some shipments of crude manganese ore, the figures of which are not included in this report. The principal properties shipping ore were the Black Eagle, Trench, and World's Fair.

Nogales district.—Some sulphide copper ore was shipped from the Arizona European property, which is opened by a 200-foot vertical shaft, and smaller productions were made from three other properties.

Oro Blanco district.—The Montana property was abandoned and the concentration mill dismantled in February, 1918. The total production of the property was considerable, but was made at a loss. The products consisted of a lead concentrate and a lead-zinc concentrate containing silver and gold. The company[1] operating the Montana mine published the following paragraphs in its annual printed report:

> Additional development work was carried on which proved the vein at a depth of 450 feet on its dip too narrow to permit profitable operation, so the option on the mine was not exercised and the equipment was removed from the property.
>
> During the term of the option approximately 1,250,000 pounds of lead, 1,300,000 pounds of zinc, and 47,635 ounces of silver were produced as concentrate. This material was produced at a time when labor was scarce and inefficient (Mexican labor being unprocurable) and sold during a period of depression in the lead and zinc markets. The operating profit was approximately $25,000, thus incurring a loss of about $350,000, divided about equally between mine development and surface equipment.

Three other mines in the district made small shipments.

Palmetto district.—The principal production of the district was from the Three R. mine, which has a 200-ton mill that yielded a copper concentrate, which was shipped to the El Paso smelter. A small quantity of first-class sulphide copper ore was also shipped.

Patagonia district.—Although 10 producers reported production, the principal part of the output was shipped from the Duquesne mines and consisted of copper ore, lead ore, and zinc ore aggregating 30,000 tons. This property was closed in the early months of 1919 and its milling and mining equipment was being disposed of at the time of the writer's visit in April. Other properties producing were the Santa Nino, Morning Glory, Mowry, Jarillas, and Golden Gate.

Red Rock district.—Copper-lead ore from the Frisco Fair claim was shipped to the smelter.

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[1] Goldfield Consolidated Mines Co. Twelfth Ann. Rept., for year ending Dec. 31, 1918.

Tyndall district.—From the Wandering Jew and Florida properties some ore containing lead was shipped, and a portion of it was milled and yielded some lead concentrate.

Wrightson district.—Seven producers reported 297 tons of ore, containing gold, silver, copper, and lead, valued at $13,887, or an average value per ton of $46.76. The American Boy property, under extensive development, produced some copper sulphide ore, containing a little silver and gold. .There were also small shipments made from the Castle Butte, Dixie, Ruby, and Lee properties.

YAVAPAI COUNTY.

Mine production in Yavapai County, Ariz., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	88	1,176,644	$1,023,464	2,207,583	159,612,146	686,874	950,762	$46,572,677
1918	93	1,301,828	1,117,701	2,502,968	148,882,695	348,389	357,380	40,451,953
Increase or decrease	....	+125,184	+94,237	+295,385	−10,729,451	−338,485	−593,382	−6,120,724

[a] Includes placer production.

Eighty-eight deep mines and five placers in Yavapai County reported a total metal output valued at $40,451,953 in 1918, against $46,572,677 in 1917, when 88 operators of deep mines and placers reported. The value per ton of the ore decreased from $39.58 in 1917 to $31.07 in 1918, but the gold and silver value per ton in this ore increased from $2.41 to $2.78. Of the total value of the metals reported, $1,117,701 was for gold, $2,502,968 was for silver, $36,774,026 for copper, $24,736 for lead, and $32,522 for zinc. Compared with that of 1917, the output of gold and silver shows a substantial increase, but the output of copper, lead, and zinc was considerably less. First-class ore shipped to various smelters aggregated 1,119,441 tons. Most of the shipments was copper ores (1,095,507 tons in quantity), of which the larger part was sulphide ore (1,074,546 tons) and the remainder was oxidized copper ore (20,961 tons). The total value of the smelting ores was $37,818,781, or an average value per ton of $33.78. There were produced 45,205 tons of dry or siliceous ore, mostly siliceous silver ore the larger part of which was treated at smelting plants, and the greater part of the remainder was treated at a cyanidation plant. Concentrates amounting to 42,246 tons, derived from 159,978 tons of ore, were smelted and contained $160,855 in gold, 216,516 ounces of silver, and 7,891,298 pounds of copper, valued in all at $2,326,522, or an average value per ton of $55.04. The placer output amounted to $2,191 in gold and 14 ounces of silver, as against the production of 1917 (partly estimated) of $3,762 in gold and 22 ounces of silver.

Agua Fria district.—The Binghampton property proved to be the largest producer in the district in 1918, having operated its 250-ton flotation mill and shipped concentrate to the Humboldt smelter. There were smaller shipments of copper ore from the Gold Dot and Swiss Girl properties.

Big Bug district.—From an output of 141,338 tons of ore made at 25 deep mines and 1 placer was derived $227,168 in gold, 254,027 ounces of silver, 7,936,339 pounds of copper, and 169,004 pounds of lead, valued in all at $2,453,470. Compared with the output of 1917, the quantity of ore and the total value are greater. In 1918, there were 79,752 tons of ore, carrying copper and lead, shipped directly to the smelters and 61,085 tons milled, producing concentrate. Gold and silver bullion resulted from the treatment of 344 tons of ore in amalgamation mills. The principal producing mine in the district was the Blue Bell, followed by the Henrietta. There were also shipments of sulphide lead ore from the Arizona National, Holden, and Silver Bell properties. From the Gladstone-McCabe property some old tailings were shipped to the smelter, and from the Locey Pabst mine some gold bullion and concentrates were recovered from siliceous ore. A few shipments of copper ore were made from the Sterling property. Owing to the higher prices paid for metals contained in ores, there was very little placer mining performed, and only $544 in gold and silver was reported in 1918.

The Consolidated Arizona Smelting Co., operating the Blue Bell mine near Mayer and the concentration mill and smelter at Humboldt, gave in its annual statement some interesting statistics of production and costs. The following paragraphs form part of the detailed report:[1]

> During 1918 we started a campaign of exploration by means of a diamond drill, and 3,112 feet of drilling were accomplished at a cost of $9,142.35, equal to $2.938 per foot. The exploration planned at the outset was only half completed during the course of the year and fully justified the expenditure made since it resulted in the discovery of three new ore bodies, two of which have since been opened up and put on a producing basis. Both of these ore bodies are located in the hanging wall of the main vein and have been productive of a good grade of ore, although unfortunately, they are of limited size. * * *
>
> The total reserve of ore estimated as positive, highly probable, and probable on January 1, 1919, was 470,000 tons, of which 15,593 tons was broken in the stopes. The estimated reserves show a decrease of 66,800 tons during the past year, during which period 131,090 tons of ore were produced and shipped from the mine. The fact that the reserves have decreased must not be considered as indicating any really serious condition or any material falling off in the future prospects of the mine, but this condition is simply brought about by the fact that development during the past year could not proceed at a rate to keep pace with the production. * * *
>
> The average grade of all ore included in this estimate is figured at $2.50 in gold and silver, and 2.80 per cent copper. * * *
>
> The Blue Bell mine made a record production of 131,090 tons of ore, containing on the average $1.26 value in gold, $1.50 value in silver, and 2.771 per cent copper. * * *
>
> At the present time the output of the Blue Bell mine is slightly less than 400 tons per day, which is about the maximum that can be efficiently handled by the present mine equipment, and during this year it is probable that our production will fall below that of 1918, since economic conditions do not make it advantageous to push the mine to the limit of its capacity. * * *
>
> The concentrator operated continuously throughout the year and treated 104,633 tons of ore, or 1 per cent less than in 1917. The operations of the mill were limited by the output of the mines, and fully 20 per cent additional ore could have been concentrated had this extra tonnage been available. The Blue Bell mine has recently been producing from the lower levels ore which is considerably more basic (that is, higher in iron content) and also higher in gold and silver values, and this fact, coupled with improvements in our smelter and shortage of custom material during the last part of 1918, made it advantageous to use a considerably larger proportion of the Blue Bell output

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[1] Consolidated Arizona Smelting Co. Ann. Rept. for year ending Dec. 31, 1918.

directly to the smelter, instead of putting this ore through the mill and smelting the resultant concentrates.

The mill treated 62,343 tons of Blue Bell ore, 42,036 tons of De Soto ore, and 254 tons of old tailings. The average content of all material milled was $2.25 in gold and silver and 2.572 per cent copper. The recovery of values fell off slightly from previous records, partly due to the character of the ore treated and inefficient grinding and classification during the first eight months; also to an effort to produce a higher grade of concentrate. The recoveries made in 1918 were 89.52 per cent copper, 67.16 per cent gold, and 71.91 per cent silver. * * *

The smelter treated a total of 160,328 tons of new metal-bearing material, an increase of 15 per cent over the tonnage smelted in 1917. The recovery of values in material treated was 95.07 per cent gold, 92.30 per cent silver, and 93.82 per cent copper. The total production of the smelter was 14,178 ounces of gold, 442,809 ounces of silver, and 18,800,073 pounds of copper.

The production was derived as follows:

	Gold.	Silver.	Copper.
	Ounces.	*Ounces.*	*Pounds.*
From domestic material (Blue Bell and De Soto ores and concentrates)	8,409	204,660	8,514,177
From custom material	5,769	238,149	10,285,896

The custom material was purchased from 67 shippers, and principally from the United Verde Extension Mining Co., the Arizona-Binghampton Copper Co., the Swansea Lease (Inc.), Bradshaw Reduction Co., Jerome-Verde Copper Co., Swastika Development Co., and the Phelps Dodge Corporation (Copper Basin branch).

The United Verde Extension, which shipped monthly approximately 1,000,000 pounds of copper to our smelter during the early part of the year, blew in its own smelter at Verde during the month of June, and thereafter the most important source of our custom ore supply was cut off.

Black Canyon district.—Two properties, the Silver Cord and the Brooks, produced small quantities of oxidized lead ore, which was shipped to the smelters.

Black Hills district.—A small quantity of sulphide copper ore was produced from the Yaeger Canyon property, operated by the Shannon Copper Co.

Black Rock district.—Five deep mines produced ore containing gold, silver, and copper, valued at $1,037. Some of the ore was treated by amalgamation, but most of it was gold ore and was milled in the 50-ton flotation plant at the Copper Hill property.

Copper Basin district.—From the operations of the Copper Basin and Senator properties copper ore, containing silver, was shipped directly to the smelters at Douglas, Clarkdale, and Humboldt. There were also smaller shipments from the Copper Hill and Loma Prieta properties.

The Copper Basin mine[1] shipped 38,323 dry tons of ore, containing 1,907,205 pounds of copper, as paid for by the smelters. Most of the ore was smelted at Clarkdale and Douglas, and some of it went to Verde and Humboldt. The Copper Basin mine is operated by the Phelps Dodge Corporation, whose annual report gives details as follows:

Development and prospect work totaled 1,320 feet. On account of the shortage and high cost of labor, little prospecting was done on the outside surface showings at Copper Basin.

While the tonnage of ore reserves at the end of the year compares favorably with that at the beginning of the year, the average copper content is lower.

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[1] Phelps Dodge Corporation Ann. Rept. for year ending Dec. 31, 1918.

Owing to the low ruling price for copper since the first of the present year, operations have been suspended.

During the year a bunk house for our workmen was built at the mine, and a pipe line 14,000 feet in length installed from Government Springs to the property.

On the Senator group the Snoozer raise was holed to the Snoozer shaft and the shaft repaired from the 105-foot level to the surface. The Snoozer ore shoot was opened on this level and produced for shipment 477 tons of ore containing 61,250 pounds of copper, 3,380 ounces of silver, and 22.79 ounces of gold, as paid for by the smelter.

Eureka district.—From the Copper King mine, operated by the Arizona Hillside Co., the only producer in 1918, considerable sulphide zinc ore was shipped to reduction plants in Arkansas for treatment.

Hassayampa district.—Fifteen producers reported 2,916 tons of ore, containing $15,072 in gold, 17,176 ounces of silver, 10,494 pounds of copper, and 126,964 pounds of lead, valued in all at $43,875, or an average value per ton of $15.05. The greater part of the ore, produced principally from the Big Pine property, was treated in a cyanidation mill, and 297 tons of ore from various properties were shipped directly to the smelters. This ore contained 46.91 ounces of gold, 5,965 ounces of silver, 10,494 pounds of copper, and 126,964 pounds of lead. Some ore was also treated in the Climax mill, which is equipped for amalgamation and concentration. Other properties making shipments of ore were the Davis, Crook, and Surprise mines.

Humbug district.—The Silver Crown claim produced a small quantity of ore containing silver.

Peck district.—The Consolidated Arizona Co. made shipments from the De Soto, Nora B., and Silver Prince (Swastika) properties. The principal part of the production of the district came from the De Soto mine and was shipped to Humboldt for reduction. The annual report of the company[1] operating the property gives the following paragraphs:

No diamond drilling was carried on at the De Soto mine, but exploration and development to the extent of 874½ feet of advance was accomplished, at a cost of $16,949.61, equal to $19.39 per foot of advance. This charge was borne by the ore produced from the mine and amounted to $0.3954 per ton of ore produced. * * *

The total reserves of positive, highly probable, and probable ore was estimated on January 1, 1919, at 33,000 tons. A considerable portion of this reserve is comparatively low in grade and the average value is figured at $2.30 in gold and silver, and 2.60 per cent copper. At the De Soto mine as well as at the Blue Bell mine the content in gold and silver has tended to increase during the past few years, while the copper content has gradually diminished.

The production from the De Soto mine was a trifle less than in 1917, amounting to 42,870 tons, containing on the average $1.54 in gold, $1.20 in silver, and 2.576 per cent copper. At the present time the rate of production is approximately 100 tons per day and we hope to maintain this rate throughout at least the greater part of the present year, although it is not certain that this can be done.

The cost of the De Soto ore f. o. b. Humboldt was $3.6857 per ton, or 10 cents less than the cost of ore from the Blue Bell. This cost also shows an increase over previous years, amounting to an additional 53 cents since 1917. A part of this increase was found in the extra charge of 26 cents per ton because of additional development work, and also since July 1, 1918, the freight has been increased from 70 cents to 90 cents per ton from the shipping point at Middleton to Humboldt. Here (as at Blue Bell) we hope and expect that the average cost of production will show a decrease in 1919.

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[1] Consolidated Arizona Mining Co. Ann. Rept. for the year ending Dec. 31, 1918.

The De Soto mine, since reopening in 1915, has produced a total of 130,095 tons of ore, and there is still a considerable amount of unexplored ground, and we have not lost hope in the discovery of new ore bodies or in finding further extensions of those ore shoots in which we are now working.

Pine Grove district.—Ore mined from the Wild Flower mine and some old tailings from the Old Tiger property were treated by the Bradshaw Reduction Co., at Crownking, where a concentrate containing more than 200 ounces of silver per ton and also some copper concentrate were produced and sold to the smelter at Humboldt.

Silver Mountain district.—At the Monte Carlo property a small quantity of bullion was recovered from ore treated in an arrastre.

Tiger district.—The principal operations were performed on the Tiger Gold mine, where ore was amalgamated and concentrated and produced bullion and a high-grade gold concentrate. Other producers shipping ore directly to the smelter were the Red Cross and the Cougar properties.

Turkey district.—The R. and H. mine produced a small quantity of siliceous silver ore, containing copper, which was shipped to the smelter at Humboldt.

Verde district.—Seven producers reported the output of 1,011,966 tons of ore, containing $771,578 in gold, 1,986,845 ounces of silver, 133,780,865 pounds of copper, and 7,962 pounds of lead, valued in all at $35,802,862, or an average value per ton of $35.38. All the ore was of smelting grade, with the exception of 15,951 tons, which was treated by cyanidation. There was also some copper recovered in the form of precipitate from mine water. The principal producers were the United Verde and United Verde Extension properties, and smaller shipments were reported from the Dundee, Jerome Verde, and Shea properties. From the Copper Chief mine, operated by the Hayden Development Co., a small quantity of crude ore was shipped, but the larger part of the production was treated in the 125-ton cyanide plant on the property. It is said that this mill was closed November 15, 1918, on account of the rapidly rising costs due to war conditions.

The United Verde mine, the largest producer in the district, is reported[1] to be able to produce and treat at the Clarkdale smelter an assemblage of ores, practically all primary, averaging about 5 per cent of copper and yielding about 90 pounds of copper, 1.5 ounces of silver, and 35 cents per ton in gold. It is assumed that this grade was much higher in the earlier years of the mine and that it has slowly declined. It is probable, however, that by careful mining the grade may be maintained at its present level for a number of years, although it is planned to increase the output to 1,000,000 tons of ore a year, increasing the present quantity by about 25 per cent. This will mean that the output of copper will rise to 90,000,000 or perhaps 100,000,000 pounds a year in the near future.

From the annual report of the United Verde Extension property[2] are taken the following paragraphs reviewing operations:

The most important event of the year was the completion of our new smelter. This plant was put in operation in the month of July and is now treating all the ores produced by the company's mine. Since starting operations we have treated 71,257 tons of our own ore, which produced 23,229,335 pounds of copper, 2,431 ounces of gold, and 279,414 ounces of silver, an average per ton of 326 pounds of copper, 0.0341 ounce of gold, and 3.92 ounces of silver.

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[1] Finlay, J. R., The Jerome district of Arizona, Part II: Eng. and Min. Jour., vol. 106, pp. 605–610, Oct. 8, 1918.

[2] United Verde Extension Mining Co. Directors' Rept. for year ending Dec. 31, 1918.

We also treated 3,435 tons of custom ore, which produced 292,951 pounds of copper, 59 ounces of gold, 4,657 ounces of silver.

Prior to starting operations at our own smelter, we shipped during the year to the different custom smelters 62,277 tons of ore. * * *

No prospecting work has been done and no new ore body has been developed. Development work will be undertaken in an active manner on the completion of the Audrey shaft. During the year this shaft has been concreted and completed to the 1,400 level, and is in operation to that depth. Further, it has been sunk to the 1,700 level with a good sump in the bottom. The cutting of a pump station and ore pockets for the shaft is now in progress.

Among the more important developments of the district is that made by the Gadsden Copper Co.,[1] which reports as follows:

The shaft was sunk to a depth of 1,230 feet and a crosscut started west on the 1,200 level. The Jerome fault is estimated to be from 1,300 to 1,600 feet away at this level, and at this time the crosscut is 1,100 feet long. The drift has cut a very much broken schist and porphyry formation with traces of copper minerals here and there and considerable water, which is handled by electric pumps.

The present intention is to drive west as far as the Jerome fault and then to drift parallel to the fault and do further crosscutting from this drift at such points as may seem best as development proceeds.

Walker district.—The total output of the district, made by 12 operators, aggregated $6,575, including the output of 3 placers. Eighty-nine tons of ore, produced from the underground mines and shipped to the smelters, contained $2,331 in gold, 1,432 ounces of silver, 3,181 pounds of copper, and 5,356 pounds of lead, valued in all, at $4,928, or an average value per ton of $55.37. Most of the production of the deep mines was from old properties operated by lessees, notably the Eureka, Amulet, and Virginia claims. Preparations were made for operating elevator dredges on Lynx Creek, which may be the source of gold in 1919. Only $1,647 in gold and silver was reported by dealers as having been purchased from several placer operators along the creek in 1918.

Weaver district.—Some siliceous gold ore was produced from one property in the district in 1918. Merchants reported the purchase of a very small quantity of placer gold, but it is possible that the Survey did not get reports from all producers who sold their gold directly to jewelers and other dealers.

YUMA COUNTY.

Forty-three deep-mine operators in Yuma County in 1918 reported the output of 33,939 tons of ore, which was 13,294 tons less than was reported by 52 producers in 1917. The total average value per ton of this ore decreased from $21.95 in 1917 to $18.71 in 1918, but the gold and silver value increased from 90 cents to $1.09. The total value of the gold, silver, copper, and lead produced in the county was $636,085, as against $1;042,233 in 1917. The placer production amounted to $1,100 in gold and 8 ounces of silver, against $5,586 in gold and 61 ounces of silver in 1917. Ore of shipping grade aggregated 30,910 tons, containing $22,044 in gold, 4,752 ounces of silver, 2,337,217 pounds of copper, and 97,526 pounds of lead. At gold and silver mills 89 tons of ore were treated, and produced 85.56 ounces of gold and 75 ounces of silver.

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[1] Calumet & Arizona Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

Castle Dome district.—Ten producers reported 2,329 tons of ore in 1918, containing $552 in gold, 4,275 ounces of silver, 9,070 pounds of copper, and 183,519 pounds of lead, valued in all at $20,097, or an average value per ton of $8.63. The larger part of this ore was of concentrating grade and produced lead concentrate, and a small part of the total produced bullion. There were 154 tons of ore, containing silver and a little copper, shipped to the smelter. The principal operations, which lasted only until May and June, were on the Ophir property, which is equipped with a 75-ton concentration mill. Shipments of lead ore were also made from the Sonora claim.

Cienega district.—Copper ore from the Billy Mack and Empire Arizona properties comprised nearly the entire production of the district in 1918. The Illinois Copper Co. had the latter property under development and is sinking a deep shaft between the Lion Hill and the Billy Mack Hill mines.

Ellsworth district.—Sixteen producers reported the mining in 1918 of 1,747 tons of ore, containing $16,023 in gold, 441 ounces of silver, and 387,595 pounds of copper, valued in all at $112,200, or an average value per ton of $64.22. Nearly all of the output was of shipping grade and only 27 tons were milled, producing gold bullion. The Critic mine, producing sulphide copper ore containing considerable gold, was the principal producer in the district. There were also shipments from the Little Giant, Mohawk, and Bullard properties.

Kofa district.—Some gold bullion and a small quantity of lead ore, containing silver, were shipped from the Kofa district by a lessee in 1918. One merchant reported some gold and silver recovered by amalgamation from disintegrated vein quartz.

Palomas district.—Some ore from the Silver Prince property yielded silver-bearing lead ore.

Planet district.—Copper ore was shipped from the Clara property, operated by the Swansea Lease (Inc.). The production of this property, combined with a few shipments from two other mines, comprised the entire output of the district in 1918.

Plomosa district.—Seven deep-mine producers reported 294 tons of ore, containing principally copper and some silver and gold and having a total value of $11,269, or an average value per ton of $38.33. The principal producers were the Blue State, Desert, Dutchman, and Shamrock properties. The Abe Lincoln and Garfield claims produced a small quantity of placer gold. There was also some gold from the Plomosa Placers, near Quartzsite. Altogether $907 in gold and silver was reported from dry placer operations.

Silver district.—Milling ore mined from the Red Cloud property produced lead concentrate, containing silver and a little gold.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN UTAH.[1]

(MINES REPORT.)

By V. C. Heikes.

PRODUCTION.

GENERAL STATEMENT.

The output of gold, silver, copper, lead, and zinc from Utah mines was valued at $86,047,597, a decrease of $13,280,558 in 1918, compared with 1917. There were 248 lode producers and 3 placers, as against 331 lode producers and 3 placers in 1917. There was a decrease in the output of ore and in the production and value of all the metals, except silver. Gold decreased from $3,355,156 in 1917 to $2,949,170 in 1918; silver increased in value from $11,106,806 to $13,455,597; copper decreased from $67,342,044 to $56,110,899; lead decreased in value to $11,857,584, or $3,495,304 less than in 1917; recoverable zinc decreased from $2,171,261 to $1,674,347 in 1918; and the placer output of gold increased from $112 in 1917 to $1,368 in 1918.

Mine production of gold, silver, copper, lead, and zinc in Utah in 1917–18.

Year	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	334	15,358,481	$3,355,156	13,479,133	246,674,153	178,521,958	21,286,871	$99,328,155
1918	251	14,705,718	2,949,170	13,455,597	227,169,630	167,008,224	18,399,417	86,047,597
Decrease in 1918	......	652,763	405,986	23,536	19,504,523	11,513,734	2,887,454	13,280,558
1864–1918	......	....	96,068,503	379,476,124	2,189,332,043	4,142,608,381	210,357,026	[b]1,002,202,934

[a] Includes small placer production.
[b] The total by years to the end of 1913 appears in Mineral Resources, 1913, pt. 1, p. 366, 1914.

Since the year 1864 the mines of Utah have produced gold, silver, copper, lead, and zinc valued at $1,002,202,934. This includes $96,068,503 in gold, $285,244,421 in silver, $402,792,339 in copper, $200,573,430 in lead, and $17,524,241 in zinc. Dividends paid by 22 producers in 1918 amounted to $15,778,551. In the history of the State dividends paid to stockholders of mining property, representing more than 85 mines, have amounted to $198,024,367.

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[1] The statistical tables in this report were compiled by Bessie N. Patchell, of the United States Geological Survey.

A discussion of the geology of the mining districts and their production, from the beginning of mining in Utah to the end of 1917, by B. S. Butler, G. F. Loughlin, F. C. Calkins, and others, will soon be issued by the United States Geological Survey as Professional Paper 111.

ORE.

In 1918 there were sold or treated 14,705,718 short tons of ore, containing recoverable metals valued at $86,046,214, a decrease of 652,763 tons, compared with the production of 1917. The total average value per ton was $5.85 in 1918, against $6.47 in 1917, but the gold and silver value per ton increased from 94 cents to $1.12. The low-grade disseminated copper ore produced in 1918 was less by 695,822 tons, a greater decrease than in any other class of ore.

The output of dry or siliceous ore increased from 164,057 tons in 1917 to 227,356 tons in 1918. This classification includes 222 tons of siliceous gold ores, averaging $33.50 in gold, 8.70 ounces of silver, and 0.087 pound of lead per ton. Gold and silver mixed ore, dry or siliceous in character, was produced from only one property. The siliceous silver ores mined in 1918 by 36 producers amounted to 227,129 tons and averaged per ton $2.03 in gold, 17.54 ounces of silver, 14.04 pounds of copper, and 5.34 pounds of lead, against the output of 50 operators in 1917 producing 124,011 tons, which averaged $1.81 in gold, 17.19 ounces of silver, 7.90 pounds of copper, and 7.87 pounds of lead. The Tintic Standard mine in the Tintic district was the heaviest producer of silver ore, followed by the Dragon, Centennial-Eureka, Iron Blossom, Chief Consolidated, and Victoria mines. The Ontario mine, at Park City, was next in importance as a shipper of silver ore. The chloridizing roasting process was used only in the Tintic district in 1918, and 63,695 tons of siliceous silver ores were directly treated and yielded a base bullion of copper, silver, and gold. This bullion was treated at eastern refineries.

The copper ore mined by 83 producers amounted to 13,512,274 tons, which contained 11 cents in gold and 0.11 ounce of silver a ton, and 0.80 per cent of copper, and averaged $4.20 a ton in value. Comparison with ore of similar character in 1917 shows that the quantity decreased 609,397 tons, the gold and silver content was considerably less, and the copper content decreased more than 18,000,000 pounds. Of the copper ore mined, the larger part, or 12,630,988 tons, was from the low-grade disseminated deposits. This ore and some old tailings re-treated produced 626,821 tons of copper concentrates, which were smelted. There was 431,063 tons of copper ore smelted directly, of which 351,599 tons was sulphide ore, assaying $1.21 in gold and 1.55 ounces of silver per ton, and 2.06 per cent of copper, and valued in all, at $12.94 per ton; and 79,464 tons was oxidized ore, assaying $1.24 in gold and 4.92 ounces of silver per ton, and 3.78 per cent of copper, valued in all at $24.57 per ton.

A decided decrease was made in the mining of lead ore. The output of 154 producers in 1918 aggregated 527,759 tons and averaged 79 cents in gold and 12.64 ounces of silver per ton, and 0.46 per cent of copper and 10.75 per cent of lead, and $30.97 in total value per ton. Of this output, 372,716 tons of sulphide and oxidized ores in about equal quantities were shipped directly to the smelters, the total quantity averaging $1.01 in gold and 16.35 ounces of silver per ton, 0.54 per cent of copper and 13.36 per cent of lead, and $39.00 in value per ton. Of the lead ore, 142,913 tons was concentrated, yielding 34,208 tons of lead concentrate averaging 88 cents in gold and 14.92 ounces of silver per ton, and 1.12 per cent of copper and 17.43 per cent of lead, and $45.77 in total value per ton. Lead concentrate from 291,246 tons of lead-zinc ore aggregated 108,639 tons, averaging $4.28 in gold and 9.05 ounces of silver per ton, and 0.59 per cent of copper and 21.41 per cent of lead, and $46.66 in total value per ton.

Zinc ore shipped from 9 properties in 1918 aggregated 1,849 tons against 6,535 tons from 22 producers in 1917. All the zinc ore produced in 1918 was oxidized and of smelting grade and averaged 27.68 per cent of recoverable zinc, with a little lead. At the Judge electrolytic zinc plant, near Park City, high-grade zinc was successfully produced in 1918. Zinc concentrates saved from lead-zinc ore milled aggregated 8,217 tons and averaged 74 cents in gold and 2.12 ounces of silver per ton, 0.22 per cent of copper, 1.81 per cent of lead, and 35.63 per cent of recoverable zinc. Zinc concentrates were also recovered from tailing and averaged 35.21 per cent of recoverable zinc.

Thirteen lead-zinc producers in 1918 reported 428,985 tons of ore and old tailings re-treated. The ore was milled, making a lead concentrate and a zinc concentrate. The tailings yielded 19,648 tons of lead-zinc concentrates, which averaged 73 cents in gold and 12.34 ounces of silver per ton, and 0.87 per cent of copper, 10.56 per cent of lead, and 28.64 per cent of zinc and $84.52 in value per ton. There was 767 tons of lead-zinc ore shipped to smelters, averaging 17.42 per cent of recoverable zinc and 10.74 per cent of lead, valued at $46.92 per ton.

Copper-lead ore, most of it oxidized or carbonates, increased from 6,443 tons produced by 28 mines in 1917 to 7,495 tons produced by 15 mines in 1918. Of this ore, 2,492 tons was of smelting grade and averaged 40 cents in gold and 21.21 ounces of silver per ton, and 3.43 per cent of copper, 16.32 per cent of lead, and $61.74 in value per ton. The remainder of the copper-lead product was 3 tons of sorted slag and 5,000 tons of old tailing.

Concentrates of all kinds produced in Utah in 1918, including those heretofore mentioned, aggregated 803,021 tons and contained nearly 53 per cent of the gold, against more than 45 per cent in 1917; more than 17 per cent of the silver, against more than 18 per cent in 1917; nearly 87 per cent of the copper, against more than 85 per cent; nearly 38 per cent of the lead, against 30 per cent in 1917; and nearly 93 per cent of the zinc, against more than 79 per cent in 1917. In 1918 the recoverable metal content of the concentrates was valued at $58,550,544, or a total average value per ton of $72.91, as against a total value in 1917 of $67,283,690, or a total average value per ton of $82.73.

Crude ore of all kinds shipped directly to the smelters represented nearly 7 per cent, or 967,597 tons, of the total output and produced nearly 46 per cent of the gold in 1918, against nearly 54 per cent in 1917; nearly 79 per cent of the silver against nearly 78 per cent; nearly 12 per cent of the copper, against more than 14 per cent; nearly 61 per cent of the lead, against 70 per cent; and more than 7 per cent of the zinc, against nearly 21 per cent in 1917. In 1918 the total value of the crude ore shipped to smelters was $26,012,964, or an average value per ton of $26.88, as against a total value in 1917 of $31,344,169, or an average value per ton of $26.61.

At mills using cyanidation and amalgamation a small output of gold and silver was recovered from 1,012 tons of ore. The value of the gold and silver recovered from this ore was $8,730, or an average value per ton of $8.63. In 1917 the recovery of gold and silver from ores given similar treatment was valued at $2,929, or an average value per ton of $15.42.

Ore and metals produced in Utah in 1918.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	3		$1,368	15			
Dry or siliceous	46	227,356	471,637	3,987,068	3,189,201	1,214,547	
Copper	83	13,512,274	1,570,234	1,445,559	217,252,784	2,557	
Lead	154	527,759	418,098	6,672,725	4,843,721	113,517,267	
Zinc	9	1,849	41	215		6,090	1,021,761
Copper-lead	15	7,495	2,459	106,377	219,476	1,125,021	
Lead-zinc	13	428,985	485,333	1,243,638	1,664,448	51,142,742	17,377,656
		14,705,718	2,949,170	13,455,597	227,169,630	167,008,224	18,399,417

Ore sold or treated in Utah in 1918, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	2,779	241,157	28,913		35	33,158	306,042
Box Elder	222	5,984	993	693		395	8,287
Cache		28					28
Garfield	5						5
Juab	141,539	48,027	114,303	160	14	372	304,415
Millard		49					49
Morgan			286				286
Piute	974		2,069				3,043
Salt Lake	2,946	13,206,377	185,217		284	347,284	13,742,108
Summit	30,961		73,836		5,000	7,000	116,797
Tooele	4,040	9,840	85,407	856	2,162		102,305
Uinta		1					1
Utah	43,788	27	27,066	140			71,021
Wasatch	87		9,669			40,776	50,532
Washington	15	784					799
	[a]227,356	13,512,274	527,759	1,849	7,495	428,985	14,705,718
Value per ton in gold and silver	$19.61	$0.22	$13.43	$0.14	$14.52	$4.03	$1.12

[a] Includes 222 tons of gold ore, 5 tons of gold and silver ore, and 227,129 tons of silver ore.

GOLD.

Producers in Utah in 1918 reported the output of $2,949,170 in gold—a decrease of $405,986 compared with 1917. The largest part of the gold was contained in ores produced in Salt Lake County and amounted to $2,083,254, against $2,268,684 in 1917; Juab County ranked next, with $628,593, against $843,609 in 1917; and Tooele County mines were credited with $23,703, against $32,344 in 1917. Bingham district produced $2,056,005 and Tintic district $678,952; in 1917 these outputs were, respectively, $2,241,152 and $868,547. Placer gold was produced in Grand and Uinta counties and amounted to $1,368, against $112 in 1917. Ores treated in mills equipped for amalgamation produced $1,291 in gold in 1918 from 112 tons of ore mined in Box Elder, Garfield, Juab, Piute, and Washington counties. Cyanidation of ore was reported by only one operator in 1918. Concentrates of copper, lead, copper-lead, lead-zinc, and zinc ore, and a small quantity of siliceous concentrate contained altogether $1,561,157 in gold, against $1,522,982 in 1917. Copper concentrates contained the largest quantity of gold, or 50,518.31 ounces, against 50,280.80 ounces in 1917, 47,028.69 ounces in 1916, 37,836.53 ounces in 1915, 35,863.89 ounces in 1914, and 29,699.38 ounces in 1913; the lead concentrates contained 23,936.54 ounces, against 22,522.72 ounces in 1917; and the zinc concentrates 294.87 ounces, against 294.14 ounces in 1917. Lead-zinc concentrates in 1918 produced 697.36 ounces of gold, against 571 ounces in 1917, and copper-lead concentrate contained 70.75 ounces of gold.

A large part of the gold produced in Utah is a by-product of the copper and lead ores. Ranking first in 1918, the Utah copper property is credited with 50,928.22 ounces. The United States property at Bingham reported about 81 per cent of its output of gold as contained in lead ores and concentrate and the remainder in copper ores. Next in importance as producers of gold, named in order of production, were the Highland Boy, with 13,307 ounces, and the Centennial Eureka.

Little straight siliceous gold ore has been mined in Utah in recent years, though a few cars were shipped from the Wedge mine, near Marysvale, and by lessees from the Blue Bird workings of the Annie Laurie mine, at Gold Mountain, in Piute County.

Mine production of gold in Utah in 1918, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver		85.36	517.24	1,254.09			36.47	1,893.16
Box Elder		41.42		74.68				116.10
Garfield		2.85						2.85
Grand	40.20							40.20
Juab		19,691.08	4,532.33	6,179.09	1.98	3.71		30,408.19
Millard			3.72					3.72
Piute		359.27		1,381.22				1,740.49
Salt Lake		178.54	70,598.95	6,822.71		13.23	23,163.98	100,777.41
Summit		889.30		2,506.95		70.75	20.55	3,487.55
Tooele		94.22	305.12	716.02		31.27		1,146.63
Uinta	25.98							25.98
Utah		1,461.82	2.71	1,047.92				2,512.45
Wasatch		1.71		242.81			256.98	501.50
Washington		9.87						9.87
	66.18	[a] 22,815.44	75,960.07	20,225.49	1.98	118.96	23,477.98	142,666.10

[a] Includes 359.70 ounces from gold ores, 101.75 ounces from gold and silver ores, and 22,353.99 ounces from silver ores.

SILVER.

The mine production of silver in Utah in 1918 was 13,455,597 ounces, valued at $13,455,597, an increase of 23,536 ounces in quantity, and of $2,348,791 in value. The largest production was from Juab County, credited with 4,994,806 ounces, against 4,988,005 ounces in 1917. Salt Lake County had the next largest output, 3,022,638 ounces in 1918, against 3,769,884 ounces in 1917. The Bingham district, in Salt Lake County, produced 2,437,758 ounces, or nearly 81 per cent of the county total; the Tintic district, in Juab and Utah counties, 6,681,644 ounces, and the Park City region, in Summit and Wasatch counties, 2,572,586 ounces. Concentrates produced at milling plants yielded 2,316,766 ounces of silver, against 2,469,804 ounces in 1917. The copper ores milled produced 509,298 ounces in 1918, against 525,923 ounces in 1917, 488,742 ounces in 1916, 412,745 ounces in 1915, 358,486 ounces in 1914, and 324,586 ounces in 1913. Lead concentrate from low-grade lead ore contained 1,494,122 ounces of silver, or an average per ton of 10.46 ounces, in 1918, against 1,675,899 ounces, or an average of 12.80 ounces, in 1917; zinc concentrate contained 2.12 ounces per ton, against 9.34 ounces per ton in 1917; lead-zinc concentrate contained 12.34 ounces per ton, and copper-lead concentrate contained 96.22 ounces per ton, in 1918.

The silver content of bullion produced from ores treated by amalgamation was 365 ounces, against 26 ounces in 1917. Only one operator reported cyanidation of silver ores in 1918. At Silver City a leaching mill using a chloridizing roast on custom ores recovers a rich silver bullion, from which 413,498 ounces were reported in 1918.

Nine properties each produced more than 500,000 ounces of silver in 1918. The Chief Consolidated, in the Tintic district, ranked first, with an output of 2,354,798 ounces, followed by the Tintic Standard, in the same district, the Ontario, at Park City, the United States mines, and the Utah Apex, at Bingham, the Eagle & Blue Bell mine and Iron Blossom, in the Tintic district, the Utah Copper, at Bingham, and the Judge mine, at Park City.

Mine production of silver in Utah in 1918, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver		10,903	18,819	253,800		472	66,321	350,315
Box Elder		7,216	261	13,532				21,009
Cache			17					17
Garfield		2						2
Grand	9							9
Juab		1,567,802	347,845	3,078,055	215	889		4,994,806
Morgan				1,220				1,220
Piute		5,643		61,676				67,319
Salt Lake		29,474	1,041,416	1,027,196		6,693	917,859	3,022,638
Summit		952,579		1,049,224		53,403	6,186	2,061,392
Tooele		41,428	36,404	568,423		44,920		691,175
Uinta	6		2					8
Utah		1,370,587	795	363,107				1,734,489
Wasatch		1,430		256,492			253,272	511,194
Washington		4						4
	15	[a]3,987,068	1,445,559	6,672,725	215	106,377	1,243,638	13,455,597

[a] Includes 1,932 ounces from gold ore, 1,690 ounces from gold and silver ore, and 3,983,446 ounces from silver ore.

COPPER.

The consumption of copper in 1918 was under Government direction, which continued until near the end of the year. With the removal of Government control of prices the demand disappeared entirely for a time and there was no definite market quotation for the metal.

In 1918 there were produced 227,169,630 pounds of copper, valued at $56,110,899—a decrease of 19,504,523 pounds in quantity and of $11,231,145 in value. The Bingham or West Mountain district in Salt Lake County produced 211,194,861 pounds of copper in 1918, against 225,411,675 pounds in 1917, 223,619,609 pounds in 1916, 176,593,414 pounds in 1915, 141,924,811 pounds in 1914, 144,920,494 pounds in 1913, 116,621,793 pounds in 1912, and 129,995,865 pounds in 1911; the Tintic district in Juab County produced 6,568,802 pounds in 1918, against 9,117,723 pounds in 1917; the Park City region in Summit and Wasatch counties produced 915,649 pounds, against 1,285,308 pounds in 1917; Beaver County, 2,635,564 pounds, against 3,702,085 pounds in 1917; and Tooele County, 2,531,769 pounds, against 4,181,231 pounds in 1917.

Concentrates of all kinds produced at Utah milling plants contained 196,912,158 pounds of copper, against 210,127,703 pounds in 1917. Copper concentrates contained 194,436,026 pounds, against 207,603,875 pounds in 1917; lead concentrates, 2,048,480 pounds, against 2,134,184 pounds in 1917; zinc concentrates, 36,724 pounds, against 168,483 pounds in 1917; lead-zinc concentrates, 342,898 pounds, against 219,167 pounds in 1917; and copper-lead concentrates, 48,030 pounds. Crude ore shipped to smelters contained 27,157,575 pounds of copper, against 35,688,301 pounds in 1917. The crude copper ore smelted contained 20,409,801 pounds, of which 14,487,964 pounds was from sulphide ores and 5,921,837 pounds was from oxidized ores. Lead ores smelted produced 4,012,394 pounds of copper, the sulphide ores yielding 2,914,708 pounds and the oxidized ores 1,097,686 pounds. Copper-lead ores, which were mostly oxidized, contained 170,963 pounds of copper. The dry or siliceous ores, used principally for fluxing at smelting plants, contained 2,564,417 pounds, against 1,760,377 pounds in 1917. The low-grade copper-bearing disseminated ores mined and concentrated contained 194,381,368 pounds of copper, against 208,768,759 pounds in 1917, 199,996,870 pounds in 1916, 156,040,257 pounds in 1915, 125,777,441 pounds in 1914, 126,364,491 pounds in 1913, and 102,662,335 pounds in 1912. Part of the tailing of the Cactus mill, in Beaver County, was reworked and the output is included above.

The leading producers of copper named in order of production were the Utah Copper Co., reporting[1] 188,092,405 net pounds; the Highland Boy, 8,476,197 pounds;[2] and the Ohio Copper Co.

Mine production of copper in Utah, in 1918, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper lead ore.	Lead-zinc ore.	Total.
Beaver	38,424	2,494,823	95,313	3,426	3,578	2,635,564
Box Elder		878,621	6,786			885,407
Cache		2,333				2,333
Juab	2,434,820	3,194,417	265,049	1,937		5,896,223
Millard		3,795				3,795
Piute			15,921			15,921
Salt Lake	86,916	209,538,011	2,118,479	17,254	1,476,313	213,236,973
Summit	43,996		450,259	48,030	2,037	544,322
Tooele	2,373	776,309	1,604,258	148,829		2,531,769
Uinta		372				372
Utah	582,672	6,307	98,849			687,828
Wasatch			188,807		182,520	371,327
Washington		357,796				357,796
	[a]3,189,201	217,252,784	4,843,721	219,476	1,664,448	227,169,630

[a] All from silver ore.

LEAD.

It is said that the price of lead has not responded to the increased cost of production. The last increase in 1918, which brought the price up to 8.05 cents a pound, was more than discounted by increased freight, labor, and smelter charges, and, therefore, the margin between the price and the cost is still lower than in normal times and the future relation can not be predicted.

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[1] Utah Copper Co. Fourteenth Ann. Rept., for year ending Dec. 31, 1918.

[2] Utah Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

The mine production of lead in Utah in 1918 was 167,008,224 pounds and was 11,513,734 pounds less than the output in 1917. The Bingham or West Mountain district produced 79,773,150 pounds, an increase in 1918 compared with 73,523,708 pounds in 1917, 85,996,490 pounds in 1916, 80,004,006 pounds in 1915, 76,453,128 pounds in 1914, 71,001,138 pounds in 1913, and 43,822,495 pounds in 1912. The greatest part of the production at Bingham came from the Utah Apex, Utah Metal, Highland Boy, and Dalton & Lark mines. The Park City region produced 24,320,074 pounds of lead, against 33,715,565 pounds in 1917. The Tintic district produced 30,652,358 pounds, against 35,078,949 pounds in 1917. The combined production of Ophir and Rush Valley districts, in Tooele County, aggregated 12,912,350 pounds, against 12,896,789 pounds in 1917. The output in Beaver County increased from 5,321,400 pounds in 1917 to 6,506,428 pounds in 1918. Lead contained in total concentrate recovered at milling plants and shipped to smelters amounted to 63,074,196 pounds, against 53,956,225 pounds in 1917. The lead concentrates from lead and lead-zinc ores averaged 20.41 per cent of lead in 1918, against 19.61 per cent in 1917; zinc concentrates contained 297,432 pounds, averaging 1.81 per cent of lead in 1918, against 2.33 per cent in 1917. The total crude ore of shipping grade contained 101,811,651 pounds, against 124,429,731 pounds in 1917. Sulphide lead ore contained 53,868,105 pounds of lead, against 61,284,562 pounds in 1917. The oxidized lead ores carried 45,743,869 pounds, against 59,881,443 pounds in 1917.

Of the zinc ores shipped in 1918, the oxidized ores contained 6,090 pounds of lead. No sulphide ores were reported. Of the copper-lead ores, the oxidized or carbonate ores contained 770,452 pounds and the sulphide ores 43,357 pounds of lead.

Ranking first in the output of lead in 1918 was the Utah Apex mine, at Bingham, followed by the United States mines, also at Bingham, and the Silver King Coalition, at Park City, named in order of production. Each of these was credited with more than 10,000,000 pounds of lead. Those closely following were the Highland Boy, Eagle & Blue Bell, Chief Consolidated, and Judge mines.

Mine production of lead in Utah in 1918, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	1,564		5,695,685		7,659	801,520	6,506,428
Box Elder	386		291,403			83,856	375,645
Juab			25,732,601	6,090	4,667	80,500	25,823,858
Morgan			104,107				104,107
Piute			317,286				317,286
Salt Lake	112,245	2,557	43,320,688		51,590	45,194,792	88,681,872
Summit	1,097,431		14,885,644		310,150	68,025	16,361,250
Tooele	2,921		13,443,675		750,955		14,197,551
Utah			6,681,403				6,681,403
Wasatch			3,044,775			4,914,049	7,958,824
	[a] 1,214,547	2,557	113,517,267	6,090	1,125,021	51,142,742	167,008,224

[a] Includes 386 pounds from gold ore, 635 pounds from gold and silver ore, and 1,213,526 pounds from silver ore.

ZINC.

Bingham district, Park City district, and Beaver County, named in order of production, were the chief producers of zinc. Smaller quantities were produced in the North Tintic and Promontory districts. The total mine production of recoverable zinc in Utah in 1918 was 18,399,417 pounds, valued at $1,674,347, against 21,286,871 pounds, valued at $2,171,261, in 1917. The Judge property, at Park City, continued to be an important producer. Salt Lake County, with Bingham as the principal source, produced 11,160,521 pounds of recoverable zinc, against 8,826,658 pounds in 1917. Beaver County decreased its output from 4,133,464 pounds in 1917 to 2,518,987 pounds in 1918. The Tintic district decreased its output from 1,182,941 pounds in 1917 to 264,820 pounds in 1918.

Lead-zinc ore and old tailings aggregating 428,985 tons were smelted or milled, of which 767 tons of ore was shipped directly to the smelters and 291,246 tons of ore and 136,972 tons of old tailings were concentrated and yielded 108,639 tons of lead concentrate, 8,217 tons of zinc concentrate, and 19,648 tons of lead-zinc concentrate. The old tailings yielded 836 tons of lead concentrate, 181 tons of zinc concentrate, and 15,068 tons of lead-zinc concentrate, all of which were included above. The lead-zinc ore and tailing concentrates shipped to smelting works contained 17,377,656 pounds of recoverable zinc, of which 267,214 pounds were contained in crude lead-zinc ore, 5,854,901 pounds in zinc concentrate, and 11,255,541 pounds in lead-zinc concentrate. Most of the last-mentioned product was from the tailing operations at Frisco and Midvale, and the remainder came from the ore of the Judge mine at Park City.

Nearly all the lead-zinc product was treated at electrolytic zinc works at Great Falls, Mont., and Park City, Utah, and some was shipped to manufacturers of zinc oxide in the Eastern States. Crude zinc ores and lead-zinc ores smelted contained 1,288,975 pounds of zinc, of which 1,021,761 pounds was derived from zinc ores and 267,214 pounds from lead-zinc ores. In 1918 the oxidized zinc and lead-zinc ore predominated and produced, respectively, 1,161,378 pounds and 127,597 pounds of recoverable zinc, the latter being produced from the sulphide ores.

The leaders in the output of zinc in 1918 were the properties of the United States Mining Co., at Bingham and Midvale, and the Judge property, near Park City, followed by the tailing mill at Frisco and the Utah Apex at Bingham.

Mine production of recoverable zinc in Utah in 1918, in dry pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Beaver		2,518,987	2,518,987
Box Elder	316,056	139,617	455,673
Juab	90,464	127,597	218,061
Salt Lake		11,160,521	11,160,521
Summit		103,849	103,849
Tooele	517,600		517,600
Utah	97,641		97,641
Wasatch		3,327,085	3,327,085
	1,021,761	17,377,656	18,399,417

Zinc ore and concentrates produced from Utah mines and mills sold in 1918.

Classification.	County.	Quantity, dry weight.	Average assay of ore or concentrates.
		Short tons.	*Per cent.*
Sulphide lead-zinc ore	Jaub	[a] 372	20.16
Mixed carbonate and siliceous ore	Box Elder, Juab, Tooele, and Utah	2,244	30.49
Concentrates	Beaver, Salt Lake, Summit, and Wasatch	27,865	36.56
		30,481	35.91

[a] Averaged 15.14 per cent of lead and sold to oxide manufacturers in the Eastern States.

METAL-MINING INDUSTRY IN UTAH IN 1918.

The discouraging features of the operations for the year 1918 were the serious shortage of competent and efficient labor and the high cost, uncertainty, and failure to make deliveries of practically all materials used. Because of these adverse conditions, development, and exploratory work were of necessity reduced to a minimum. There was a reduction in the earnings of many companies due to several causes, chief of which were the lower prices obtained for lead and copper and the increase in freight rates effective June 25, 1918. The increase in freight rates amounted to 25 per cent on shipments from mine to smelter and 55 per cent on shipments of bullion from smelter to refinery. Both of these increases were charged against ores in the form of increased deductions by the smelters. Two increases in the wage scale were made during 1918, and increases in cost of supplies were general. In the closing months of the year some mining camps were placed under strict quarantine. The influenza caused the death of many miners and the enforced absence from duty of many others.

The increase in freight rates[1] went into effect June 25, 1918, all class and commodity rates being advanced 25 per cent, with a heavy flat increase on base bullion. The increases on ores shipped to the smelting companies in the Salt Lake Valley ranged from 10 cents to $3.03 on ores worth up to $300 per ton. The new schedule applied a 30-cent flat increase per ton on iron ores shipped to the smelting furnaces for fluxing purposes. The highest increase on ores from within the State was from the Deep Creek region, on which the rate was raised $2.125 a ton on $40 ore, with corresponding raises on ores of less value. The increase on bullion from smelting plants to the East was $6.50 a ton, an advance of 65 per cent, making a freight rate of $16.50 a ton on base bullion. This increase was passed along to the producer, as the smelters made additional deductions from New York metal quotations to offset it. Wage increases of 25 cents and of 50 cents per shift were made at Park City and Tintic on April 1 and again later in the year, so that prevailing wages were the same as at Bingham in practically all the camps, the scale being: Muckers, $4.75; hand miners, $5; machine men, $5.25; machine helpers, $5; timber men, $5.25; trammers, $4.75; and laborers, $4. Wages at Alta were increased on August 1, and wages were also advanced at the smelting and milling plants. A semimonthly pay day was adopted in some camps. The prevailing scale for common labor in smelting and milling plants in October was: Arthur and Magma, $4.25 a day; Garfield, $3.65 a day; Murray and Midvale, $3.55 a day. During the first six months of 1918 mining, development, and operating costs increased 33 to 65 per cent. The increased costs are reflected directly in the dividends.

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[1] Zalinski, E. R., Mining in Utah in 1918: Eng. and Min. Jour., vol. 107, p. 178, Jan. 25, 1919.

METALLURGIC INDUSTRY.

GENERAL STATEMENT.

Some gold was reported from the amalgamation of ores mined in Box Elder, Garfield, Juab, Piute, and Washington counties. The output for 1918 from gold and silver mills was derived from 112 tons of ore, and consisted of 62.47 fine ounces of gold and 365 fine ounces of silver, recovered by amalgamation. The total value was $1,656. Some ore was treated by cyanidation in Piute County, near Marysvale.

Of the 26 plants operated in 1918 in Utah, 1 was an amalgamation plant, 1 used amalgamation and concentration, 1 concentration and cyanidation, and 23 were concentration plants. Ten of the concentration plants were equipped with tables followed by the oil flotation process, and three used flotation alone. One plant was equipped for wet concentration followed by magnetic separation. There were three leaching plants, of which one, near Park City, used the electrolytic method of recovering zinc from solution, and another plant, at Silver City, gave the ores a chloridizing roast. At Magma, the Utah Copper Co. operated its sulphuric-acid leaching plant for treatment of low-grade oxidized copper ore.

Mine production of metals from Utah concentrates, in 1918.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaver	4,482	9,700	487.73	92,428	1,695,214	1,060,738	2,518,987	$825,768
Box Elder	....	1	1.80	8	....	386	....	72
Juab	....	30	3.83	960	545	6,038	....	1,603
Salt Lake	12,920,829	752,894	73,866.90	1,456,636	194,395,708	46,491,756	11,160,521	55,315,862
Summit	49,125	12,836	839.23	317,649	134,769	5,777,998	103,849	787,974
Tooele	44,258	14,289	44.44	164,314	489,887	3,482,053	....	533,461
Utah	11,682	1,947	20.04	81,499	13,515	1,341,178	....	130,475
Wasatch	40,776	11,324	257.00	253,272	182,520	4,914,049	8,327,085	955,329
	13,071,152	803,021	75,520.97	2,316,766	196,912,158	63,074,196	17,110,442	58,550,544

By kinds of concentrates.

Siliceous	1	3.14	2	....	....	....	$67
Copper	631,753	50,518.31	509,298	194,436,026	....	....	49,579,302
Lead	142,847	23,936.54	1,494,122	2,048,480	58,314,054	....	6,635,207
Zinc	8,217	294.87	17,434	36,724	297,432	5,854,901	586,514
Copper-lead	555	70.75	53,403	48,030	310,150	....	88,749
Lead-zinc	19,648	697.36	242,507	342,898	4,152,560	11,255,541	1,660,705

Smelting rates were advanced several times during 1918 on account of increased wages and cost of coke and other supplies, though there was no scarcity of coke.

Four smelting plants situated near Salt Lake City were operated at capacity the first half of 1918. There was a fair supply of ore, and surplus capacity was used in treating material from the large stock piles accumulated in 1917. Later, more of the stock piles were made to replace the decrease in current production. At the end of October the Midvale plant of the United States Smelting Co. operated 5 and sometimes 6 of its 7 furnaces on lead ore; the Murray plant of the American Smelting & Refining Co. had 5 of its 8 furnaces treating lead ore; and the Garfield copper plant had 4 reverberatory furnaces and 2 blast furnaces in operation. At the International plant, near Tooele, the lead section operated 5 furnaces at nearly full capacity, and 2 reverberatory furnaces were in blast treating copper ores. There were smelted at International[1] in 1918, 262,722 tons of copper ore and 297,847 tons of lead ore, from which were produced 21,821,657 pounds of fine copper, 62,034,920 pounds of fine lead, 5,827,134 ounces of silver, and 36,317.307 ounces of gold.

The new copper leaching plant of the Utah Copper Co.,[2] designed to handle the oxidized capping that is stripped from above the principal mass of sulphide ore bodies in Bingham Canyon, is giving satisfactory results. The capping contains about 0.65 per cent of copper, which is largely in the form of carbonates. The plant has a capacity of 2,000 tons of ore a day and is arranged so that the material is handled mechanically with the smallest amount of labor.

Mine production of metals from Utah crude ore shipped to smelters in 1918.

By counties.

County.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaver	33,726	930.83	200,297	906,550	3,662,250		$703,476
Box Elder	8,212	90.99	20,996	885,407	375,259	455,673	309,682
Cache	28		17	2,333			593
Juab	247,685	29,446.19	4,657,198	5,268,810	25,817,820	218,061	8,420,210
Millard	49	3.72		3,795			1,014
Morgan	286		1,220		104,107		8,612
Piute	2,142	1,598.71	63,158	15,921	317,286		122,665
Salt Lake	502,984	26,814.99	1,555,629	16,402,101	41,851,179		9,132,697
Summit	55,672	2,648.32	1,743,743	409,553	10,583,252		2,651,060
Tooele	54,113	1,011.18	486,785	2,041,882	10,715,498	517,600	1,819,936
Uinta	1		2	372			94
Utah	52,159	2,348.99	1,625,621	674,248	5,340,225	97,641	2,228,759
Wasatch	9,756	244.50	257,922	188,807	3,044,775		525,790
Washington	784			357,796			88,376
	967,597	65,138.42	10,612,588	27,157,575	101,811,651	1,288,975	26,012,964

By kinds of ore.

Dry or siliceous	158,710	21,440.40	3,528,959	2,564,417	1,214,161		4,691,788
Copper	431,063	25,402.34	934,781	20,409,801	1,261		6,501,205
Lead	372,716	18,245.81	6,095,788	4,012,394	99,611,974		14,536,473
Zinc	1,849	2.00	215		6,090	1,021,761	93,668
Copper-lead	2,492	47.87	52,845	170,963	813,809		153,844
Lead-zinc	767				164,356	267,214	35,986

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[1] Anaconda Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

[2] Min. and Sci. Press, vol. 117, p. 787, Dec. 14, 1918.

PRODUCTION BY COUNTIES.

GENERAL FEATURES.

Mine production of gold, silver, copper, lead, and zinc in Utah in 1918.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.			
	Fine ounces.		*Fine ounces.*			*Fine ounces.*	
Beaver			1,893.16	$39,135	$39,135	350,315	$350,315
Box Elder			116.10	2,400	2,400	21,009	21,009
Cache						17	17
Garfield			2.85	59	59	2	2
Grand	40.20	$831			831	9	9
Juab			30,408.19	628,593	628,593	4,994,806	4,994,806
Millard			3.72	77	77		
Morgan						1,220	1,220
Piute			1,740.49	35,979	35,979	67,319	67,319
Salt Lake			100,777.41	2,083,254	2,083,254	3,022,638	3,022,638
Summit			3,487.55	72,094	72,094	2,061,392	2,061,392
Tooele			1,146.63	23,703	23,703	691,175	691,175
Uinta	25.98	537			537	8	8
Utah			2,512.45	51,937	51,937	1,734,489	1,734,489
Wasatch			501.50	10,367	10,367	511,194	511,194
Washington			9.87	204	204	4	4
	66.18	1,368	142,599.92	2,947,802	2,949,170	13,455,597	13,455,597

County.	Copper.		Lead.		Recoverable zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Beaver	2,635,564	$650,984	6,506,428	$461,956	2,518,987	$229,228	$1,731,618
Box Elder	885,407	218,696	375,645	26,671	455,673	41,466	310,242
Cache	2,333	576					593
Garfield							61
Grand							840
Juab	5,896,223	1,456,367	25,823,858	1,833,494	218,061	19,844	8,933,104
Millard	3,795	937					1,014
Morgan			104,107	7,392			8,612
Piute	15,921	3,932	317,286	22,527			129,757
Salt Lake	213,236,973	52,669,532	88,681,872	6,296,413	11,160,521	1,015,607	65,087,444
Summit	544,322	134,448	16,361,250	1,161,649	103,849	9,450	3,439,033
Tooele	2,531,769	625,347	14,197,551	1,008,026	517,600	47,102	2,395,353
Uinta	372	92					637
Utah	687,828	169,894	6,681,403	474,380	97,641	8,885	2,439,585
Wasatch	371,327	91,718	7,958,824	565,076	3,327,085	302,765	1,481,120
Washington	357,796	88,376					88,584
	227,169,630	56,110,899	167,008,224	11,857,584	18,399,417	1,674,347	86,047,597

Ore sold or treated, number of deep mines producing and value of ores in Utah in 1917 and 1918.

County.	Ore sold or treated.		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	1918	Increase or decrease.	1917	1918	1917	1918	1917	1918
	Short tons.	*Short tons.*						
Beaver	306,042	−1,996	60	40	$7.08	$5.66	$0.94	$1.27
Box Elder	8,287	−5,702	12	7	37.65	37.44	1.48	2.82
Cache	28	−29	1	1	23.35	21.18	.75	.61
Emery		−17	1		98.18		.82	
Garfield	5	−19	1	1	58.17	12.20	26.87	12.20
Grand		−86	7		91.06		45.22	
Iron		−449	3		32.80		2.83	
Juab	304,415	−59,945	51	40	27.83	29.35	13.60	18.48
Millard	49	−129	5	1	32.86	20.69	3.89	1.57
Morgan	286	+115	1	1	41.30	30.11	3.39	4.27
Piute	3,043	+915	7	5	52.45	42.64	28.20	33.95
Salt Lake	13,742,108	−521,572	80	71	5.30	4.74	.38	.37
San Juan		−28	1		148.78		3.32	
Sanpete		−16	1		31.25			
Summit	116,797	−58,123	14	8	25.78	29.44	11.30	18.28
Tooele	102,305	−29,743	61	51	24.64	23.41	5.19	6.99
Uinta	1	−4	3	1	250.00	94.00	3.40	2.00
Utah	71,021	+38,748	16	15	32.98	34.35	16.64	25.15
Wasatch	50,532	−15,158	3	3	27.43	29.31	8.44	10.32
Washington	799	+475	3	3	117.55	110.86	.11	.26
	14,705,718	−652,763	331	248	6.47	5.85	.91	1.12

[a] Value per ton, placer product excluded.

BEAVER COUNTY.

Mine production in Beaver County, Utah, 1917–18.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total Value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	60	308,038	$45,314	297,833	3,702,085	5,321,400	4,133,464	$2,180,651
1918	40	306,042	39,135	350,315	2,635,564	6,506,428	2,518,987	1,731,618
Increase or decrease, 1918		−1,996	−6,179	+52,482	−1,066,521	+1,185,028	−1,614,477	−449,033
Total, 1860–1918			806,874	21,511,221	52,273,947	417,910,382	36,026,506	51,124,145

Beginning in 1860 Beaver County has produced gold, silver, copper, lead, and zinc amounting in total value to $51,124,145. This includes $806,874 in gold, $19,938,707 in silver, $9,129,577 in copper, $18,442,730 in lead, and $2,806,257 in zinc. The corresponding table of production by years is given to the end of 1913 in Mineral Resources for 1913, Part I, page 389.

Forty producers in 1918 reported 306,042 tons of ore, against 60 producers and 308,038 tons of ore in 1917. The total value of the output of gold, silver, copper, lead, and zinc decreased from $2,180,651 in 1917 to $1,731,618 in 1918. The quantity and the value of the metals, with the exception of silver and lead, decreased. The value of the gold decreased from $45,314 in 1917 to $39,135 in 1918; copper, from $1,010,669 to $650,984; and zinc from $421,613 to

$229,228. Silver increased from $245,415 to $350,315; and lead, from $457,640 to $461,956. The average value per ton of the ore, including some old tailing, decreased from $7.08 in 1917 to $5.66 in 1918, and the gold and silver value per ton in this ore increased from 94 cents to $1.27.

The decrease in the total value per ton was caused by the treatment of considerable low-grade tailing, and from Frisco a large tonnage of lead tailings was shipped without treatment. Of the ore mined, 4,482 tons was concentrated and produced a lead concentrate. There were 258,154 tons of tailings re-treated at Newhouse and Frisco, which produced copper concentrate, lead concentrate, and lead-zinc concentrate. Altogether there were 9,700 tons of concentrates having a total value of $825,768, or $85.13 per ton, compared with 11,784 tons having a value of $1,071,384, or $90.82 per ton, in 1917. Crude ore shipped, mostly oxidized, aggregated 33,726 tons, which yielded at the smelters gold, silver, copper, lead, and zinc having a total value of $703,476, or an average value per ton of $20.86, in comparison with 52,739 tons of ore shipped in 1917, which yielded the same metals, valued at $1,106,931, or an average value per ton of $20.99.

Beaver Lake district.—The Copper Mountain and O. K. mines were the only properties yielding copper ore in 1918 from the operations of lessees.

Bradshaw district.—One small lot of oxidized copper ore, containing a little silver, was shipped from the Copper Glance claim.

Lincoln district.—The Wandel Exploration Co. shipped a number of cars of ore, carrying a low percentage of lead and a little silver, from properties leased in the district. There was also some oxidized copper ore from the Rattler mine, and lead sulphide ore from the Lincoln property, shipped directly to the smelters. The Creole property produced oxidized iron ore and some copper ore, containing silver and gold; and some silver ore was shipped from the Stampede claim.

Preuss district.—Lead ore, containing silver and a little gold, was shipped from the Indian Queen property.

Rocky district.—Heavy shipments of ore continued to be made from the Montreal property and from the Old Hickory and Copper Ranch mines. Nearly all of this ore was oxidized iron ore, containing a little copper, chiefly valuable as a flux at the smelters. In 1918 the district yielded, altogether, 14,892 tons of ore, containing $763 in gold, 4,830 ounces of silver, and 686,519 pounds of copper, valued in all at $175,163, or an average value per ton of $11.76.

San Francisco district.—Six producers reported an output of 11,963 tons of smelting ore and 4,482 tons of concentrates. Nearly half of the concentrate was produced from the old Cactus tailing at Newhouse, and most of the remainder was a lead-zinc concentrate and some lead concentrate from the Caldo Mining Co., which leased the tailing dump of the Horn Silver property. Experiments in the use of the Peck process on the Horn Silver tailing dump resulted in the shipment of some concentrate, and a large quantity of tailings was shipped to the smelter without previous treatment. On the Carbonate-Rattler property a small flotation mill reduced lead-silver ore that yielded a good grade of concentrate. In 1918 the total content of the product shipped from the district was $32,670 in gold, 304,894 ounces of silver, 1,805,110 pounds of copper, 5,699,568 pounds of lead, and 2,514,487 pounds of zinc, valued in all at $1,416,913.

At the Horn Silver mine[1] developments disclosed ore in the No. 4 cross break, south of the old stopes. From the surface to the 400-foot level this cross break has produced considerable ore in small bodies and there is said to be a large quantity of ore in place, all of which is in limestone. On the north on the 900 and 1,000 foot levels shipping ore is exposed. The company continued its investigations of processes to treat its low-grade ore, of which there is a large quantity, and for the recovery of silver and lead from its extensive tailing dump. Altogether there are about 180,000 tons of low-grade ore and tailing to be treated. The shipments in 1918 consisted of lead ore, copper ore, and lead concentrate. From 11,712 dry tons of lead ore, containing silver, the sum of $171,700 was realized. There were also 170 tons of copper ore, the proceeds of which were $1,951, and 646 tons of lead-silver concentrate, which sold for $7,582. The total output returned $181,235.

At Newhouse the Utah Leasing Co. continued to concentrate by flotation the Cactus tailing, which contains approximately 0.7 per cent of copper. A recent article[2] gives the flow sheet of the mill, describes the process, and mentions costs. So far as known, there are no similar operations being successfully carried on in this country where a direct mill feed of such low metal content is being treated. Mill results for September 19, 1918, show the feed to contain 0.584 per cent of copper; concentrate, 16.85 per cent of copper; and tailing, 0.202 per cent of copper.

Star districts (*North and South*).—In 1918 there were produced from the Star districts by 22 mine operators, 4,292 tons of ore, containing $2,961 in gold, 32,548 ounces of silver, 57,777 pounds of copper, 747,324 pounds of lead, and 4,500 pounds of zinc, valued in all at $103,250, or an average value per ton of $24.06. A small quantity of concentrate reduced from some old tailings, containing principally lead and zinc, was included in the output. The Lady Bryan, Wild Bill, Monitor, and Red Warrior properties were the principal producers. Smaller shipments of ore were made from the Commonwealth, Paloma, St. Mary, and several old mine dumps.

BOX ELDER COUNTY.

Ashbrook district.—Ore from the Vipont property was shipped from Oakley, Idaho, on the Oregon Short Line Railroad. The ore carried about 40 per cent of silica, 4 per cent of iron, and 22 per cent of lime, and contained from 12 to 79 ounces of silver a ton.

Lucin district.—The Copper Mountain property, operated by the Salt Lake Copper Co., and the Tecoma mine were the principal producers, each of them producing oxidized copper ore and some lead ore. There was also some oxidized zinc ore shipped to the Murray smelter for experimental purposes from the Tecoma mine.

Park Valley district.—The Susannah mine in 1918 yielded some ore which was treated in an amalgamation mill and produced bullion containing gold and silver.

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[1] Horn Silver Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

[2] Adams, H. H., Mill practice at flotation plant of Utah Leasing Co.: Salt Lake Min. Rev., vol. 20, pp. 21–25, Nov. 15, 1918.

Promontory district.—Lessees operating the Lakeview property shipped several hundred tons of oxidized lead-zinc ore to zinc oxide plants. There was also some zinc ore shipped which contained little or no lead.

CACHE COUNTY.

Paradise district.—The Wolf Mountain property produced a small quantity of sulphide copper ore, containing a little silver, shipped to the smelter at Garfield. The company operating the property contemplates building a concentrating mill.

GARFIELD COUNTY.

Imperial district.—From several tests made on the ores of the Bromide and Oro properties a small quantity of gold bullion was recovered.

JUAB COUNTY.

Forty producers in 1918 mined 304,415 tons of ore, containing gold, silver, copper, lead, and zinc, valued at $8,933,104, a decrease of 59,945 tons in quantity and of $1,206,959 in value, as compared with the output of 51 producers in 1917 of 364,360 tons, valued at $10,140,063. The output was mainly from the Tintic district.

Fish Springs district.—A concentration mill to treat the old mine dumps of the Utah and Last Chance properties was completed during 1918, but no report was received as to its operation. However, some oxidized lead-silver ore was shipped from the mine or sorted from the dumps.

Mount Nebo district.—From the property operated by the Eva Mining Co. some oxidized lead ore and zinc ore, containing silver, was shipped. The Nebo Lead property was a producer of lead ore.

Tintic district.—From the year 1869 to the end of 1918, inclusive, the mines of this district produced metals valued at $191,585,310, distributed as follows: Gold, $33,235,888; silver, $90,024,876; copper, $29,174,929; lead, $37,534,728; and zinc, $1,614,889. The production of the Tintic district for the year 1918 is given in the review of the operations of Juab County, although a number of important mines of the district are situated in Utah County. For a discussion of the geology and a historical review of the district the reader is referred to a recent report[1] issued by the Geological Survey.

Mine production in Tintic district, Utah, 1917–1918.

County.	Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
			Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Juab	1917	42	363,746	$842,593	4,975,854	9,045,595	30,132,739	966,035	$10,102,095
	1918	33	303,364	627,976	4,982,060	5,895,925	25,397,992	167,179	8,884,800
Utah	1917	7	28,640	25,954	582,909	72,128	4,946,210	216,906	973,461
	1918	8	59,130	50,976	1,699,584	672,877	5,254,366	97,641	2,298,706
	1917	49	392,386	868,547	5,558,763	9,117,723	35,078,949	1,182,941	11,075,556
	1918	41	362,494	678,952	6,681,644	6,568,802	30,652,358	264,820	11,183,506
Total, 1869–1918.				33,235,888	131,953,326	178,062,437	782,701,784	17,068,473	191,585,310

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[1] Lindgren, Waldemar, and Loughlin, G. F., Geology and ore deposits of the Tintic mining district, Utah: U. S. Geol. Survey Prof. Paper 107, 1919.

The value of the metals produced in 1918 was distributed as follows: Gold, $678,952, against $868,547 in 1917; silver, $6,681,644, against $4,580,421 in 1917; copper, $1,622,494, against $2,489,138 in 1917; lead, $2,176,317, against $3,016,789 in 1917; zinc, $24,099, against $120,661 in 1917.

Altogether in 1918 there were 41 producers in the district whose output was valued at $11,183,506, or an average per ton of ore sold or treated of $30.85. In 1917 the output was valued at $11,075,556, or an average value per ton of $28.23. The total quantity of old-mine dump material of sufficient value to ship at the prevailing high prices for the metals was smaller than in the preceding years.

Mine production in Tintic district, Utah, in 1918, by kinds of ore.

Kind of ore.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Dry or siliceous	21	185,327	21,152.90	2,938,389	3,017,492		
Copper	13	48,054	4,535.02	348,640	3,200,724		
Lead	26	128,522	7,152.70	3,393,726	348,649	30,567,191	
Zinc	3	205					137,223
Copper-lead	1	14	3.71	889	1,937	4,667	
Lead-zinc	1	372				80,500	127,597
		362,494	32,844.33	6,681,644	6,568,802	30,652,358	264,820

At the south end of the district the Tintic drain tunnel was advanced to a point 1,800 feet from its portal. The face of the tunnel is about 350 feet from the surface and is being driven at the rate of about 15 feet a day.

The Godiva mine was operated by lessees who shipped some high-grade silver ore. Work was also done on company account, a winze being sunk to the 1,400-foot level. The Eureka Hill, Yankee, and Uncle Sam properties were worked largely by lessees. The Gemini, Ridge & Valley, and others were worked on company account and also by various lessees. The May Day started new development on its lower or 1,100-foot level in mineralized ground. The Dragon Consolidated produced iron ore during the first 10 months, also silver-lead ore. Part of the Dragon workings were leased to the Tintic Milling Co., which mined and treated the lower-grade silver ore at its mill at Silver City and produced bullion. The Empire Mines Co., a consolidation of the Black Jack, Lower Mammoth, and other properties, by the Knight interests, shipped a little iron ore and occasional cars of silver-lead ore. Copper ore was shipped from the Grand Central property, one of the producers paying dividends in 1918. In May the Mammoth mine was closed on account of difficulty as to labor. There were 266 cars of ore shipped up to July.

The Tintic Standard mine was the second largest producer of silver in the State in 1918. A new ore body of considerable size was opened during the year between the 1,300-foot and 1,600-foot levels. It is situated east of the first discovery and consists of siliceous silver ore. It is said this ore can be mined without sorting, as it averages 40 ounces of silver per ton. The output of the mine in 1918 consisted of sulphide lead ore, which was shipped to a lead smelter, and silver ore, containing a little copper, which was shipped to a copper plant. The lead ore averaged 0.019 ounce of gold, 28.20 ounces of silver per ton, 0.57 per cent of copper, 25.18 per cent of lead, about 16 per cent of iron, and 50 per cent of silica. The silver ore averaged 0.034 ounce of gold, 36.12 ounces of silver per ton, 0.83 per cent of copper, about 13 per cent of iron, and 60 per cent of silica. The company mined and shipped in 1918 from its No. 5 stope on the 1,250-foot level several cars of high-grade ore, which averaged 0.037 ounce of gold and 288.65 ounces of silver per ton, 3.48 per cent of lead, 8.09 per cent of copper, 46.7 per cent of insoluble matter, 1.97 per cent of zinc, 12.8 per cent of sulphur, 9.11 per cent of speiss, and 14.02 per cent of iron. The shipments of the richer ore were discontinued, as it was found more economical to mix it with the ore of the lower grade. Surveys were arranged in 1918 for the construction of the Goshen Valley Railroad (grading commenced March, 1919), connecting the mines in this section with Iron Spur, a siding on the Denver & Rio Grande Railroad, operating between Mammoth and Salt Lake City. The total length of the branch road terminating at the Iron King mine, south of the Tintic Standard property, will be about 10 miles.

The Chief Consolidated Co., in its 1918 production of silver, broke the record held by any of the companies in the district. It was followed by the Tintic Standard, Eagle & Blue Bell, Iron Blossom, and Centennial-Eureka properties. In 1918 the pumping installation was completed in No. 1 shaft, which is discussed in the company's annual report,[1] as follows:

> This made possible the following of the ore and the opening up of the mine below the permanent water level; it is because these ores have carried good silver values that the mine has been profitably operated under the adverse conditions existing; this would not have been the case otherwise, as smelting, freight, and all operating costs are now so high as to make it impossible to mine any but the higher grades of ore. * * *
>
> The results of the geological study and the underground explorations have convinced the management that there exists a parallel ore zone approximately 3,600 feet east of the one in which the mine is being operated. It was determined to sink a shaft at that point and develop that zone; accordingly, the work was started and the shaft so placed that railroad tracks could reach it both above and below on the mountain side. These tracks have been partly completed and the shaft sunk 400 feet. * * *
>
> The development work during the year was performed in the first and oldest ore zone, throughout all the levels from the 600 to the 1,800. In the second ore zone this work was limited to the lower levels. The searching for new mineralized zones and contained ore channels was continued. One of these drifts will connect with No. 2 shaft during the coming year.
>
> The ore tonnage was produced from all the ore channels from the 600 to the 1,900 levels.
>
> The water flow below the 1,800 is not large, as it is retarded by the partly impervious limestone measures bounding this particular ore channel, but on account of the extended workings now in this area, its volume is equivalent to the capacity of the pumps. This condition was anticipated several months ago and additional pumps of 1,000 gallons capacity were ordered and preparations are in progress for their installation. The discharge column is of ample size for this increased volume and the rooms required were excavated for these units at the time the first pumps were installed.
>
> No. 2 shaft, now down 400 feet, will be completely concreted for this distance by the middle of March and sinking will again be resumed. This work is progressing as rapidly as possible under the existing difficulties of water and the nature of the porphyry.
>
> The development in the Plutus Co.'s ground was continuously performed during the year in the mineralized zone previously reported. Assays in small silver values are obtained at intervals, thus giving encouraging indications of existing ore bodies in this zone. * * *

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[1] Chief Consolidated Mining Co. Tenth Ann. Rept., for year ending Dec. 31, 1918.

Production of Chief Consolidated mine from Feb. 16, 1909, to Dec. 31, 1918.

Year.	Ore.	Gold.	Silver.	Lead.	Copper.	Zinc.
	Dry tons.	*Ounces.*	*Ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1909	1,325	120	75,849	146,028	....	....
1910	8,841	584	531,483	800,802	....	....
1911	8,063	389	306,362	825,551	....	....
1912	33,072	7,838	969,907	1,141,222	....	....
1913	51,866	4,806	1,030,132	2,597,091	117,328	....
1914	40,667	6,337	665,947	5,974,008	237,901	71,665
1915	36,412	4,634	403,854	8,232,606	5,648	622,465
1916	83,606	8,331	1,739,004	18,439,153	1,795	879,410
1917	59,950	9,175	1,534,907	10,780,540	....	600,236
1918	66,019	4,100	2,354,798	7,906,831	4,137	14,597
	389,821	46,314	9,612,243	56,843,832	366,809	2,188,373

The total amount paid by the smelting companies for the ore produced in 1918 was $1,869,819.13, from which the company realized $710,293.49 after all operating charges were deducted. Dividends were paid by the Chief Consolidated Co. in 1918, amounting to $397,900, which, added to the payments since February 3, 1913, gives a total of $1,234,870.63.

The Centennial-Eureka mine[1] produced 29,558 tons of ore. Development work in the vicinity of old stopes and also in new territory was carried on. A moderate quantity of new ore was found. No large deposits were encountered. The Bullion Beck property, operated by the same interests, produced and shipped 2,072 tons of ore.

The Eagle & Blue Bell mine[2] increased its production from 33,252 tons in 1917 to 40,370 dry tons in 1918. Nearly all the ore is carbonate, with some heavy lead sulphide. There was 39,377 dry tons of lead ore shipped to smelter, containing 2,544.52 ounces of gold, 568,111 ounces of silver, 9,389,376 pounds of lead, and 15,624 pounds of copper, valued in all at $1,077,860, which, after charges for freight, smelting, and sampling, gave smelter returns amounting to $621,853. Of the siliceous ore 992 tons was shipped, containing 60.88 ounces of gold, 10,964 ounces of silver, and 388 pounds of copper, valued in all at $11,317, and after freight and treatment charges $5,125. Dividends distributed as return of capital amounted to $178,629.20. The company's report says:

> In December ore was encountered in a crosscut driven easterly from the 1,875 south drift. This development was on a strong east and west fissure dipping northward. Practically all of the levels above have been productive from ore bodies found in the vicinity of this fissure; and, due to the character of the ore recently found at this particular horizon, we are attaching considerable importance to this new discovery.
>
> Practically the entire output during the year was obtained from two main deposits.
>
> One is designated as the 1,500 ore body; and its extensions, although occurring irregularly, have been followed down to within 30 feet of the 1,875 level and upwards to the 1,350 level. * * * Stoping on this ore body has already attained a length of over 900 feet on the general northerly and southerly strike of the mineralized zone. The deposition of ore has decidedly favored the east and west fissures crossing the main channels. In and adjacent to these fissures the ore is found in big bodies extending more or less vertically. Developments on the 1,350 south drift, 1,550, 1,700, and 1,875 levels, during the year have been confined to exploiting the numerous extensions to this deposit, and also in facilitating the mining operations.

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[1] United States Smelting, Refining & Mining Co. Thirteenth Ann. Rept., for year ending Dec. 31, 1918.

[2] Bingham Mines Co. Tenth Ann. Rept., for year ending Dec. 31, 1918.

The other main source of supply is in the North Extension claims and is found mainly below the 1,000 north drift. Stoping here has attained large dimensions and indicates a general downward trend of the ore body northward at a rather flat pitch. Developments on the 700, 1,200 and 1,350 north drifts are within the mineralized area and indications here are almost positive evidence that this second main ore deposit will extend in its irregular manner to the northern limits of the property.

The ore sales of the Iron Blossom mine[1] in 1918 amounted to $625,264.85. Hoisting equipment was placed on the 1,100-foot level of the No. 1 shaft for the purpose of following the ore exposed in the copper stopes on this and the 700-foot level. The ore bodies on these two levels are said to be distinct from each other, the 1,100-foot ore body being 700 feet south of No. 1 shaft and the 700-foot ore deposit being 700 feet north of the same shaft. With the exception of ore in the No. 6 winze at No. 3 shaft and some late developments made by the company, all ore stopes are under the leasing system. Shaft No. 1 was finished to the 2,200-foot level, which is at the proper elevation to connect ultimately with the Tintic drain tunnel now being driven.

The Victoria mine[2] yielded 5,712 dry tons of copper ore and siliceous gold-silver ore containing 906.28 ounces of gold, 113,896 ounces of silver, and 141,550 pounds of copper, valued in all at $134,477.74. After deducting freight, smelting, and sampling charges, the smelter returns amounted to $85,078.20. In addition, 1,078 dry tons of lead-silver-copper ore was shipped, containing 141.49 ounces of gold, 25,408 ounces of silver, 176,019 pounds of lead, and 23,958 pounds of copper, valued in all at $36,142, giving net smelter returns of $23,732 after the deduction of all freight, smelting, and sampling charges. The most important development was the continuation of the 1,300-foot level, which opened up low-grade ore extending from the Eagle & Blue Bell into Victoria ground, and recent developments in the latter property on and below the 1,700-foot level show the ores extending into the Victoria mine.

West Tintic district.—From the Imperial Lead property some lead ore, containing silver, was shipped to the smelter by way of the Delta branch of the Salt Lake route.

Similar ore was also shipped in 1918 from the Scotia property, operated by lessees who hauled ore by wagon to a loading station near Tintic Junction.

MILLARD COUNTY.

Detroit district.—A small quantity of oxidized copper ore was shipped from the Copper Head property in 1918.

MORGAN COUNTY.

Argenta district.—Active development work in this district on the Carbonate Hill property disclosed some promising silver-lead ore, some of which was shipped directly to the smelter.

Morgan district.—Several carloads of iron flux were shipped from the Morgan Crescent property to smelters near Salt Lake.

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[1] Iron Blossom Consolidated Mining Co. Ann. Rept. for the period from Dec. 1, 1917, to Dec. 31, 1918.

[2] Bingham Mines Co. Tenth Ann. Rept., for year ending Dec. 31, 1918.

PIUTE COUNTY.

Gold Mountain district.—Lessees operating on the Annie Laurie property shipped directly to the smelters two small cars of gold ore.

Mount Baldy district.—The operation of the mill treating the ores of the Deer Trail mine was partly successful, and some gold and silver cyanide precipitate was shipped. Also some crude lead ore, carrying silver, was shipped directly to the smelters. Experiments were carried on for most of the year in an attempt to treat the ore by a flotation process.

Ohio district.—From the Great Western mine lead ore containing some silver was shipped directly to the smelter. This property was operated by lessees in 1918. Some very rich gold ore was produced from the Wedge property.

SALT LAKE COUNTY.

In Salt Lake County 71 operators in 1918 produced 13,742,108 tons of ore, which was 521,572 tons less than was produced in 1917 by 80 operators. The total average value per ton of the ore for the gold, silver, copper, lead, and zinc content decreased from $5.30 to $4.74, and the gold and silver average value per ton of this ore decreased from 38 cents to 37 cents. A review of the principal districts follows:

Big Cottonwood and Little Cottonwood districts.—From 1867 to the end of 1918 these districts have a combined record of ore valued at $27,067,216, which includes $512,595 in gold, $13,697,175 in silver, $2,165,906 in copper, $10,652,155 in lead, and $39,385 in zinc.

Mine production in Big Cottonwood and Little Cottonwood mining districts, Utah, 1917–18.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	32	48,203	$18,611	917,512	1,163,084	11,927,552	21,721	$2,120,149
1918	23	35,269	12,066	482,136	1,715,969	6,007,253	1,121	1,344,663
Increase or decrease, 1918	....	−12,934	−6,545	−435,376	+552,885	−5,920,299	−20,600	−775,486
Total, 1867–1918	....	464,764	512,595	13,622,481	11,571,886	186,624,038	522,055	27,067,216

Twenty-three producers, 7 on the Big Cottonwood side of the divide and 16 in the Alta region, shipped in 1918 directly to the smelters 35,269 tons of ore, containing $12,066 in gold, 482,136 ounces of silver, 1,715,969 pounds of copper, 6,007,253 pounds of lead, and 1,121 pounds of zinc, valued in all at $1,344,663, or an average value per ton of $38.13. The principal producer in the Big Cottonwood district was the Cardiff property, from which an oxidized lead ore was shipped. Dump ore was milled by a lessee and a small quantity of lead concentrate was shipped. Other properties yielding ore were the Iowa Copper, American Consolidated, Maxfield, Prince of Wales, Red Bell, and Woodlawn. Properties producing in the Little Cottonwood district were the South Hecla, Michigan Utah, Rexall, Emma, Alta Michigan, Alta Consolidated, and Wasatch mines.

Shipments of ore from the Alta region were greatly retarded during the year on account of the almost impassable condition of the wagon road for the greater part of the year. This, together with the shortage of labor, greatly reduced the output of ore. The Little Cottonwood Transportation Co., operating the narrow gage railroad between Wasatch and the South Hecla mine, completed the construction of the extension line so that about 3,000 tons of South Hecla ore was handled during the fall months. The trains haul about 80 tons of ore to the trip. Each train pulls 12 to 13 cars, each carrying about 7 tons of ore.

There was shipped from the South Hecla mine[1] on account 6,912 dry tons of ore, containing 103.79 ounces of gold, 84,173 ounces of silver, 111,610 pounds of lead, and 502,924 pounds of copper, valued in all at $180,020. Out of this value, $9,242 was paid for railroad freight from Wasatch to the smelters at Murray and Garfield; $28,491 for smelting, freight on bullion to New York, refining, and selling charges; $20,085 for ore hauling from mine to railroad at Wasatch; $52,081 for labor, timber, power, supplies, weighing, and assaying; and $272 for Government freight tax; leaving a net stoping profit of $69,848. Lessees shipped 2,320 tons of crude ore, containing 61.45 ounces of gold, 28,747 ounces of silver, 127,375 pounds of lead, and 74,849 pounds of copper, valued in all at $35,472. After all charges there remained $15,673, leaving a net profit to the company of $3,855.

According to the company report, some important work was performed as follows:

> During the year the ore developments on company account have been confined mostly to the Wedge vein which had been opened near the western end of the property by the so-called Wedge shaft and levels driven along the vein at an average depth of 350 feet on its dip and by some limited but important workings on the eastern end of the vein system over a mile away from the main development. The development carried on in the Wedge vein during this year was from the 500-foot level. The lead stopes on the west side of the mine were opened on the 500-foot level and the ore body on this level appears to be fully as large as on any of the levels above and the grade of same is much better, both in silver and copper content. During the early part of the year exploration work was commenced on the eastern end of the vein system in the sulphide zone, and where the Wedge vein was penetrated a large body of copper-silver-sulphide ore was encountered. Several crosscuts have been run through the ore and it has been raised on from the 500-foot level for a distance of more than 160 feet on the dip of the ore shoot, and every indication is that the ore body is going both up and down strong and, where crosscut, shows widths of more than 20 feet, and the average assay as determined by shipments of 4,000 tons were as follows: 0.02 ounce gold, 10.4 ounces silver, 5.3 per cent copper, 25 per cent iron, and 15 per cent silica.
>
> From the present back of the raise being sent up along the dip of the ore body it is about 900 feet to the surface, and every indication is that the ore will continue and connect up with the shallow exploration pits on the surface. This development is by far the most important development ever made in the history of the company, and at no time was the indicated tonnage in the mine as great as it is at the close of this year.

Smelter district.—At the United States smelter one blast furnace was added in 1918, making a total of seven. For a short period all the furnaces were operated. During the remainder of the time either five or six furnaces were active. Milling operations on old tailings were carried on by the Midvale Mineral Co. and the Childers Leasing Co., and the product shipped from the mills, each of which used the flotation process, was a lead-zinc concentrate, nearly all of which was shipped for treatment at Anaconda and Great Falls, Mont. Some old slag from the old smelter dumps was resmelted, and several small lots of ore, the accumulations of track pickers, were sold to the smelters.

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[1] South Hecla Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

Bingham or West Mountain district.—Between 1865 and 1918, inclusive, the output of the Bingham district was valued at $33,374,195 in gold, $38,102,878 in silver, $348,773,329 in copper, $58,093,347 in lead, and $4,200,989 in zinc, or a total gross value of $482,544,738, out of which dividends (partly estimated) amounting to $102,501,917 have been paid. The production by years to the end of 1913 may be consulted in Mineral Resources for 1913, Part I, page 399.

Mine production in Bingham or West Mountain district, Utah, 1917–18.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	33	14,150,394	$2,241,152	2,786,120	225,411,675	73,523,708	4,603,474	$72,866,895
1918	36	13,607,650	2,056,005	2,437,758	211,194,861	79,773,150	5,739,150	62,845,050
Increase or decrease, 1918	....	−542,744	−185,147	−348,362	−14,216,814	+6,249,442	+1,135,676	−10,021,845
Total, 1865–1918	....	....	33,374,195	50,853,582	1,869,831,727	1,137,865,688	45,791,868	482,544,738

In 1918 the Bingham district produced 13,607,650 tons of ore, against 14,150,394 tons in 1917, 12,777,683 tons in 1916, 9,693,184 tons in 1915, 7,800,661 tons in 1914, and 9,190,374 tons in 1913. The total metallic value of the ores in 1918 was $62,845,050, or an average value per ton of $4.62, against a total of $72,866,895, with an average value per ton of $5.15 in 1917. The value of the output of gold decreased from $2,241,152 in 1917 to $2,056,005 in 1918; silver increased from $2,295,763 to $2,437,758. The value of the copper decreased from $61,537,387 to $52,165,131; lead from $6,323,039 to $5,663,894; and zinc increased from $469,554 to $522,262. Shipments of ore to the smelters amounted to 468,862 tons, against 588,715 tons in 1917, 741,840 tons in 1916, 539,939 tons in 1915, 532,130 tons in 1914, 655,634 tons in 1913, and 502,682 tons in 1912. The output of concentrating ore was 12,919,580 tons, against 13,561,679 tons in 1917, 12,034,343 tons in 1916, 9,152,918 tons in 1915, 7,268,472 tons in 1914, and 8,527,755 tons in 1913. The quantity of concentrates produced was 741,015 tons in 1918, against 743,036 tons in 1917, 676,557 tons in 1916, 523,753 tons in 1915, 435,903 tons in 1914, and 443,640 tons in 1913.

The crude smelting ore in 1918 consisted principally of low-grade copper and lead sulphides and contained 26,223.28 ounces of gold, 1,077,081 ounces of silver, 14,683,758 pounds of copper, and 35,983,493 pounds of lead, valued in all at $7,800,881, or an average value per ton of $16.64. Milling ores produced 741,015 tons of copper, lead, and zinc concentrates that contained 73,230.65 ounces of gold, 1,360,506 ounces of silver, 194,114,019 pounds of copper, 43,781,930 pounds of lead, and 5,739,150 pounds of recoverable zinc, valued in all at $54,451,261, or an average value per ton of $73.48.

Mine production in Bingham district, Utah, in 1918, by kinds of ore.

Kind of ore.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.
		Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*
Dry or siliceous	2	770	133.89	4,209	8,045	635	....
Copper	23	13,195,096	70,336.78	931,692	208,301,593	....	....
Lead	21	161,278	6,451.63	674,491	1,685,020	37,114,073	....
Copper-lead	1	45	9.19	987	2,479	18,476	....
Lead-zinc	3	250,461	22,527.74	826,379	1,197,724	42,639,966	5,739,150
	....	13,607,650	99,459.23	2,437,758	211,194,861	79,773,150	5,739,150

The Utah Copper Co. is the most important enterprise of the district. For a discussion of its early history and the mining and milling methods in use, reference is made to a series of interesting articles appearing in the Mining and Scientific Press, volume 117, beginning page 445, October 15, 1918, and ending page 860, December 28, 1918.

From the mines of the Utah Copper Co.[1] 12,160,700 tons of concentrating copper ore mined by steam shovel and 34,769 tons of smelting ore mine by underground methods from the sulphide mine were produced in 1918. These figures compare with a total of 12,542,000 tons of ore concentrated and 18,026 tons directly smelted in 1917. The Magna plant in 1918 milled 6,625,000 tons, or 18,151 tons a day, and the Arthur concentrator 5,535,700 tons, or an average of 15,166 tons daily. The total quantity of copper in concentrates was 194,168,589 pounds, and the average grade of concentrate was 16.083 per cent of copper, as compared with 204,855,118 pounds and 16.615 per cent of copper, respectively, for the previous year. The decrease in production was due mainly to the lower grade of the ore and also to the decrease in the number of tons milled. The total copper contained in leaching plant precipitates was 4,193,495 pounds. The copper contained in direct smelting ore was 1,378,392 pounds. The gross production for 1918 from all sources was 197,978,557 pounds. After making smelter deductions, the net production was 188,092,405 pounds of copper, 50,928.217 ounces of gold, and 489,483.74 ounces of silver, valued in all at $44,525,129.49. There was a distribution in 1918 of $16,244,900, of which $12,589,797.50 was dividends and $3,655,102.50 was capital distribution. The total amount distributed to stockholders, including those to December 31, 1918, was $92,015,782. From the annual report of the company the following paragraphs are taken:

> Revised calculations show that at the end of the year there was developed in the property 453,421,400 tons of ore, averaging 1.375 per cent copper, of which quantity 270,000,000 tons are classed as fully developed and 183,421,400 tons as partly developed. There was mined from the entire property prior to January 1, 1919, a total of 79,381,400 tons of ore, averaging 1.397 per cent copper, and the reserves, therefore, amount to 374,040,000 tons averaging 1.370 per cent copper. The year's addition to reserves was 2,288,000 tons in excess of the tonnage mined during that period. * * *
>
> The average grade of the ore milled at the Magna plant was 1.2026 per cent copper and at the Arthur plant 1.2545 per cent copper. The average for both plants combined was 1.2662 per cent copper, as compared with 1.3367 per cent copper for the previous year. This decrease in copper content was due to the necessity of mining a considerable quantity of low-grade ore on the upper

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[1] Utah Copper Co. Fourteenth Ann. Rept., for year ending Dec. 31, 1918.

steam-shovel levels, as well as from around the boundaries of the ore body where the ore is lower in copper than in the main part of the deposit. On the upper steam shovel levels the ore directly below the capping, for an average depth of about 100 feet, is low in copper, but being at or near the top of the mountain, it is necessary to mine it first in order to get at the better grade of ore underneath. * * *

The average extraction at both plants (Magna and Arthur) combined was 65.11 per cent, corresponding to 15.9669 pounds of copper per ton, as compared with 61.10 per cent and 16.3335 pounds per ton for the year 1917. The recovery at the Magna plant was low on account of unsettled operating conditions, caused by the various improvements underway, the comparatively low copper content in the headings, and the unusually large tonnage treated. The average normal and metallurgically economical capacity of this plant is 12,000 tons per diem, whereas a daily average of 18,151 tons was milled, in order to maintain maximum production. When the contemplated improvements at the Magna plant are completed, it will have a normal capacity of 24,000 tons daily. The Arthur plant now has a normal capacity of 16,000 tons per diem.

The leaching plant treated a total of 434,143 tons of oxidized ore, or an average of 1,190 tons per diem. The usual difficulties in starting a new plant were encountered. Shortage of labor and acid were also responsible for the small tonnage. Operations in the crushing and leaching departments were entirely satisfactory, but the capacity of the scrap-iron precipitation launders was insufficient, 'and cold weather interfered with precipitation during the winter months. Basic iron phosphate precipitated with the copper rendered the drying of the product slow and difficult. Methods for handling the precipitate have been worked out, and in the future the plant should have a normal economical capacity of about 3,000 tons per diem.

The ore averaged 0.822 per cent copper, of which 0.665 per cent, or 13.30 pounds per ton, was in soluble form. The recovery in leaching was 11.10 pounds per ton, corresponding to an extraction of 83.31 per cent of the soluble copper. The recovery of the metal from the solution, in the form of a precipitate was 0.5297 per cent, or 10.594 pounds of copper per ton. The precipitate averaged 48.7727 per cent copper, 9.6066 per cent iron, and 2.74 per cent insoluble. The consumption of 60-degree Baumé sulphuric acid averaged 55.7 pounds per ton, corresponding to 5.0 pounds of acid per pound of copper recovered in leaching.

The cost of milling at Magna was 80.23 cents per ton and at Arthur $1.0779 per ton, as compared with 62.28 cents and 78.40 cents, respectively, for the year 1917. The average cost at both plants was 92.77 cents per ton, being an increase of 23.47 cents per ton over the previous year. The cost of milling, leaching, precipitating, handling tailings, and general expense at the leaching plant averaged $1.0568 per ton. This increase at the mills and the high cost at the leaching plant may be accounted for principally in the higher cost of labor and supplies, but is also due to decreased efficiency and, in the case of the leaching plant, to the comparatively low tonnage treated. * * *

The gross production of copper for the year 1918 from all sources, by quarters, as compared to that of 1915, 1916, and 1917, was as follows:

Quarter.	1915	1916	1917	1918
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
First	26,415,995	36,673,007	43,060,450	41,276,750
Second	40,799,825	48,726,304	56,845,069	52,724,053
Third	44,766,841	61,181,870	54,999,468	54,739,678
Fourth	44,224,715	50,836,299	51,269,465	49,238,076
	156,207,376	197,417,480	206,174,442	197,978,557

The average cost per pound of net copper from concentrates was 16.142 cents, and the cost per pound for all net copper produced from concentrates, sulphide ore, and leaching plant precipitates was 16.331 cents, as compared with 12.708 cents for the previous year. No credits are taken in either of the last stated figures for income derived from gold and silver or from miscellaneous sources. For the year 1918 the income from these sources amounted to 1.798 cents per pound. The higher cost per pound is due to increased mining and milling costs, increased charges for smelting and refining, and increased freight rates. Smelting and refining charges were increased on July 1 and June 1, respectively, and freight rates on June 25. This cost includes depreciation estimates, all local, State, and Federal taxes, all fixed, general, and maintenance charges of every kind, and all expenses of smelting, transportation, refining, and selling.

The average cost per pound of net copper produced from leaching plant precipitates was 16.85 cents. In addition to the copper precipitated there remained in solution 670,000 pounds, of which 627,000 pounds is recoverable. Taking this into consideration and allowing for the additional expenses to cover precipitating, smelting, refining, and marketing of the 627,000 pounds of copper, the cost per net pound of all copper from the leaching plant will average 15.089 cents. The operation of this plant was discontinued December 31, 1918, on account of curtailment of production.

The net value of the gold and silver recovered was 0.795 cent per pound, and the miscellaneous income in Utah, including that from the Bingham & Garfield Railway, amounted to 1.003 cents per pound. The operating costs on concentrating ore, including all fixed, general, and maintenance charges for the years 1910 to 1918, inclusive, are shown in the table below:

Year.	Ore.	Mining.	Transportation.	Milling.	Total.
	Short tons.				
1910	4,340,245	$0.4097	$0.2978	$0.4663	$1.1738
1911	4,680,801	.4479	.3078	.4168	1.1725
1912	5,315,321	.4233	.2848	.4158	1.1239
1913	7,519,392	.3288	.2797	.3676	.9761
1914	6,470,166	.3232	.2782	.3536	.9550
1915	8,494,300	.2441	.2781	.3402	.8624
1916	10,994,000	.2781	.2792	.3782	.9355
1917	12,542,000	.4446	.2794	.6930	1.4170
1918	12,160,700	.5370	.2983	.9277	1.7630

The mines of the United States Co.[1] shipped during the year 41,661 tons of copper ore and 127,560 tons of lead ore. Owing to the efficient facilities for haulage and adequate development work provided in recent years, the mine responded easily to the demand for ore.

At the property of the Bingham Mines Co.[1] operations at the Dalton & Lark mines resulted in the production of lead-silver ore and copper ore and some ore by lessees. The lessees operated in the old workings of the Dalton & Lark and Commercial mines and produced 4,862 dry tons of ore, on which the company received as royalty the sum of $32,153. Dividends amounting to $375,000 were paid during the year. The output of the company in 1918, exclusive of ore mined by lessees, follows:

	Ore.	Gold.	Silver.	Lead.	Copper.	Smelter returns.
	Dry tons.	*Ounces.*	*Ounces.*	*Pounds.*	*Pounds.*	
Lead ore	2,391.10	92.554	19,521.60	432,157	58,527	$25,930.86
Copper ore	29,279.24	1,408.741	93,910.48	....	695,114	118,671.71
	31,670.34	1,501.295	113,432.08	432,157	753,641	144,602.57

Concerning developments, the following notes are taken from the annual report of the company:

> Operations were carried on at the Dalton & Lark with two shifts throughout the year. Due to adverse effects of the war, causing a shortage of skilled labor, and high costs, but little development in the way of main workings was done.

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[1] United States Smelting, Refining & Mining Co. Thirteenth Ann. Rept., for year ending Dec. 31, 1918.

[2] Bingham Mines Co. Tenth Ann. Rept., for year ending Dec. 31, 1918.

> Work on the Brooklyn deposit was conducted principally through Nos. 5 and 6 raises. A large proportion of the underground work consists of relatively small drifts and raises driven in connection with the necessary preparation for the method of mining which we employ. A large part of the output is derived from this development. Timbering is required both in development and subsequent mining, resulting in a clean product with practically all of the ore extracted.
>
> There was a material increase in the output of copper from the Lead Mine deposit. The exploration work of previous years did not indicate a product which could be mined profitably under the prevailing smelter contracts for this character of ore. Developments during the year along and adjacent to a fissure paralleling the pitch line of the deposit exposed a body of ore of shipping grade, ranging from 25 to 50 feet in width. This reserve has now been depleted from a point just above the Mascotte Tunnel to a connection with the old stopes above the 1,100 level.

From the Yosemite mine[1] 2,010 dry tons of lead and copper ore was shipped to the smelter. Of this total 1,245 tons was lead ore, containing 47.62 ounces of gold, 7,670 ounces of silver, 314,258 pounds of lead, and 12,989 pounds of copper, valued in all at $26,039. The freight, smelting, and sampling amounted to $11,448 and the smelter returns to $14,591. The copper ore, 765 tons in quantity, contained 32.14 ounces of gold, 2,519 ounces of silver, and 8,045 pounds of copper, for which $3,830 was paid by the smelter. The company report says:

> Greater depth was attained on the two ore shoots in the Lead Mine vein, but conditions were found to be much the same as on the upper levels.
>
> The crosscut on the 1,100 level, started in 1917, was continued for 200 feet, where it intercepted the footwall of the Lead Mine vein. Development in a southwesterly direction exposed numerous bunches of lead-silver, which in some cases presented a full face in the drift. A small tonnage was obtained by exploiting these showings above and below the level, but inasmuch as there was no improvement in either the quantity or quality of the ore the work here was abandoned.
>
> The Cluster ore shoot in the westerly section of the property was also prospected below the 800-foot level by a winze 100 feet deep. The ore occurrence at this lower level possesses the same characteristics as that found on upper levels and requires a great deal of labor to obtain a marketable product.

During the year the Utah Consolidated Mining Co., owning the Highland Boy mine,[1] acquired title to the adjoining Yampa property, which makes 310 acres of mineral land now owned. It also settled the litigation with the Utah Metal & Tunnel Co., but the suit against the Utah Apex Mining Co. was still pending at the end of the year. There were produced from the Highland Boy mine 8,476,197 pounds of copper, 7,812,653 pounds of lead, 306,152 ounces of silver, and 13,307 ounces of gold in 1918. Dividends were paid amounting to $450,000. The annual report of the company gives the following:

Average assay per ton of crude ore shipped from the Highland Boy mine, Utah, in 1918.

Material.	Dry ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Per cent.*	*Per cent.*
Copper-iron sulphide ore	221,651	0.054	0.82	2.03	....
Lead sulphide ore	31,725	.040	4.71	.64	15.18

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[1] Bingham Mines Co. Tenth Ann. Rept., for year ending Dec. 31, 1918.

[2] Utah Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

From the Utah Apex property[1] 194,870 tons of ore was produced in 1918, including 49,742 tons of milling ore, from which 17,247 tons of concentrate was made and shipped. The gold, silver, and lead produced consisted of 6,171 ounces of gold, 641,551 ounces of silver, and 42,811,805 pounds of lead. The average metallic content and net value of the crude shipping ore was 0.035 ounce of gold, 3.56 ounces of silver, 12.18 per cent of lead, 9.38 per cent of zinc, in all a net value of $10.05 per ton. The concentrate contained 0.048 ounce of gold, 5.01 ounces of silver, 18.3 per cent of lead, in all a net value of $22.11 per ton. Dividends declared during 1918 amounted to $264,100.

The Ohio Copper Co. completed the installation of its new 3,000-ton flotation plant, which produced copper concentrate. The plant was partly destroyed by fire in 1918. Although closed down during part of August and all of September, it produced 3,362,119 pounds of copper, compared with 5,279,259 pounds in 1917. The annual report[2] of the company says:

> The decline in output was due to a fire at the company's plant in August, which destroyed the crushing plant. The calamity completely upset all calculations of the management. The fifth and last unit of the new oil flotation plant was completed in February (1919). * * * Enough work was done, however, prior to the shutdown to show that the mill * * * should handle between 75,000 and 90,000 tons of ore a month, making a recovery of at least 75 per cent of the metal contents. * * * Development work in the mine has produced excellent results, and the proven ore reserves are estimated at 6,000,000 tons of ore, which will average 0.8 per cent of copper.

Other producers included the Silver Shield, Queen, New England, Bingham Coalition, Utah Bingham, each of which shipped lead ore. The Conger, Bingham Amalgamated, Hayes, and Montana Bingham properties produced copper ore. The last-named property also shipped a small quantity of lead ore, as well as some low-grade pyritic copper ore.

SAN JUAN COUNTY.

Reports were given out that the new 300-ton mill erected to treat the ores of the Big Indian property, in a district of the same name, had started operations in 1918, but this was probably on an experimental basis, as no production was reported. The method of reduction used in the mill is known as the Christensen sulphurous acid leaching process.

SUMMIT AND WASATCH COUNTIES.

The principal producing area in Summit and Wasatch counties is the Park City region, which embraces the Blue Ledge, Snake Creek, and Uinta districts. The two last-named districts were credited with an output in 1918 of gold, silver, copper, lead, and zinc, valued at $4,920,153. This value added to the value of the production of metals since 1870 amounts to the sum of $174,734,177, which includes $4,449,639 in gold, $101,775,472 in silver, $5,144,126 in copper, $58,101,618 in lead, and $5,263,322 in zinc. The total amount of the dividends from the district for the period 1870–1918 is $44,247,115.

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[1] Utah Apex Mining Co. Ann. Rept. for year ending Aug. 31, 1918.

[2] Ohio Copper Co. Ann. Rept. for year ending Dec. 31, 1918.

Mine production in Park City mining region, Utah, 1917–18.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	17	240,610	$110,647	2,937,438	1,285,308	33,715,565	5,201,756	$6,312,103
1918	11	167,329	82,461	2,572,586	915,649	24,320,074	3,430,934	4,920,153
Decrease, 1918	......	73,281	28,186	364,852	369,659	9,395,491	1,770,822	1,391,950
Total, 1870–1918	......	....	4,449,639	137,872,396	31,944,205	1,276,764,938	69,622,119	174,734,177

The output of ore in 1918 was 167,329 tons, as against 240,610 tons in 1917. The crude ore shipped directly to the smelters consisted of mixed lead carbonates and sulphides aggregating 65,428 tons and contained 2,892.82 ounces of gold, 2,001,665 ounces of silver, 598,360 pounds of copper, and 13,628,027 pounds of lead, valued in all at $3,176,850, or an average value per ton of $48.55. The remainder of the ore (89,901 tons) was milled, the bulk of it producing 24,160 tons of concentrates, including those from 12,000 tons of creek tailings. The concentrates contained 1,096.23 ounces of gold, 570,921 ounces of silver, 317,289 pounds of copper, 10,692,047 pounds of lead, and 3,430,934 pounds of zinc, valued in all at $1,743,303, or an average value per ton of $72.16. In 1917 the average value per ton of shipping ore was $62.05 and of concentrates $71.63.

At the Silver King Consolidated property[1] the proposed 15,000-foot adit was completed for 9,000 feet from its portal, an advance of 4,000 feet in 1918. The greater part of this distance was made through the Woodside shale, which gave place to limestone in the last 1,000 feet. These strata are upper members of the Park City formation. This adit was driven to eliminate shaft sinking, hoisting, water difficulties, and the surface transportation of ore and supplies. Anticipating these advantages, work at the King Consolidated shaft was discontinued in August. Work at the California-Comstock shaft consisted of prospecting and cleaning up the levels to the 450-foot station, where pumps were installed. The old mill (erected in 1903), which operated only 30 days after its completion, was overhauled and put in operation in November. The average assays of crude ore and concentrate shipped in 1918 are given in the Silver King Consolidated Mining Co.'s annual report as follows:

Material.	Quantity.	Gold.	Silver.	Copper.	Lead.	Value.
	Dry tons.	*Ounces per ton.*	*Ounces per ton.*	*Per cent.*	*Per cent.*	*Per ton.*
Crude ore	4,032	0.037	38.63	1.04	22.10	$49.45
Concentrate	869	.059	58.23	1.35	37.45	88.14

In continuation the report says:

> Settlement on the shipments from the new development was not made in time to be included in the 1918 business. Production from the old workings amounted to 4,032 tons of crude ore of a value, after payment of transportation

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[1] Silver King Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

and treatment charges, of $199,379.01. Concentrates aggregating 869 tons, with a net value of $76,591.56, were shipped. The total production for the year from the old workings, including both crude ore and concentrates, was 4.901 tons and the net returns $275,970.57. We produced in metals 206,357 ounces of silver, 2,433,365 pounds of lead, 199.54 ounces of gold, and 107,456 pounds of copper. * * *

The ore bodies in the King Consolidated stopes did not prove as continuous as expected. Toward the north and west boundaries of the property the ore was stoped to the boundary lines from the 1,550-foot level to the 1,700 level. This portion of the stopes proved even better than anticipated. The stopes adjacent to the main vein that showed large faces of good ore were cut off by faults, and the ore proved to be of far less extent than expected.

In addition to following the various seams and small shoots leading from the stopes a large amount of prospect work was done on the 1,700, 1,625, 1,550, and 1,100 levels. Ore was encountered in all points opened, but not in commercial quantities at existing costs for labor and material. It was therefore deemed best to temporarily close down this work and await the completion of the Spiro tunnel with its drainage facilities and a more favorable condition to continue exploitation.

The Silver King Coalition mine[1] yielded, according to the annual statement, 8,184.12 tons of first-class shipping ore and 43,042 tons of milling ore. The ratio of concentration was 4.28 tons of milling ore into 1 of concentrate. Mill operations resulted in the shipment of 9,346 tons of concentrate and 1,531 tons of middlings. Average assays of these products were reported as follows:

Kind of material.	Gold.		Silver.		Lead.		Copper.		Value.
	Per ton.	Total.	Per ton.	Total.	Per ton.	Total.	Per ton.	Total.	
	Ounces.	*Ounces.*	*Ounces.*	*Ounces.*	*Per cent.*	*Pounds.*	*Per cent.*	*Pounds.*	
First-class ore...	0.080	678.32	28.42	232,603	32.72	5,356,778	0.296	48,522	$438,048.66
Concentrate....	.066	622.60	19.92	186,197	24.30	4,543,274	.235	44,043	334,734.80
Middlings......	.048	74.04	13.83	21,265	6.72	205,723	.560	17,167	15,143.25
	....	1,374.96	....	440,065	....	10,105,775	....	109,732	787,926.71

The total dividends paid by this company and the original company to the end of 1917 amounted to $15,198,560. No dividends were paid from operations in 1918.

The Ontario mine[2] produced ore on account of both company and lessees, from which $561,768.11 was received in 1918. During the year $150,000 in dividends was paid to stockholders. From the annual report of the company the following is taken:

Prospecting and exploratory work during the year 1918 developed a number of shoots of ore between the 1,500-foot level and the 1,700-foot level, which resulted in profitable operations for the year. One shoot, of considerable extent, but containing ore of a low grade, was extensively developed between the 1,500-foot level and the 1,600-foot level. This shoot of ore has been encountered on the 1,700-foot level, and will be developed during the present year. Another shoot developed on the 1,700-foot level contained ore of higher grade, but did not prove as persistent as we anticipated, the stope continuing but a short distance above the level. A winze is being sunk on the same fissure on which this ore occurred, from the 1,700-foot level to the 1,800-foot level. For the last 60 feet in this winze we have had bunches of ore of good grade. * * *

The main working shaft is 2,000 feet deep, while the lowest level in which we are now working is 1,700 feet deep. The 2,000-foot level which was run a short distance east and west of the shaft by the former management has been under water for the past fifteen years, and it is now planned to begin unwatering the shaft to this level, and to continue drifting in both directions.

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[1] Silver King Coalition Mines Co. Ann. Rept. for the year ending Dec. 31, 1918.

[2] Ontario Silver Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

At the Daly West mine[1] leasing was entirely abolished at the end of 1918, and with a reorganization of interests the company expects to work entirely on its own account. During 1918 the sum of $184,593 was received for crude ore and concentrate shipped to the Salt Lake smelters. A crosscut tunnel of 1,000 feet, driven from the main transportation tunnel of the Judge Co. to the Daly West shaft, makes it possible to operate the Judge electric trains from the Daly West shaft directly to the ore bins of the Judge concentrator. Some ore and tailing was treated at both mills during the year.

The Judge property,[2] including concentrator and electrolytic zinc plant, was operated under adverse conditions due to the shortage of efficient labor and the high cost and uncertainty of deliveries of practically all materials used. The total ore output from the mine in 1918 was 50,255 tons dry weight (compared with 65,427 tons in 1917). There was 40,622 tons of ore concentrated, which produced 6,700 tons of lead concentrate and 4,580 tons of zinc concentrate. The company's report gives the following:

> The metal contents of the 19,176 tons of ore sold were: Silver, 508,434 ounces; gold, 489.67 ounces; lead, 7,931,566 pounds; copper, 371,036 pounds, which compare favorably with the metal contents of 19,909 tons sold in 1917.
>
> Receipts from all sources were $1,090,342.12, against expenditures of $1,152,001.56, including the dividend of $240,000, showing a reduction during the year of $61,659.44 in our cash balance. In this connection, however, attention is called to 1,602,000 pounds of high-grade spelter, approximately 1,000 tons of zinc concentrates, and 1,200 tons of residues on hand or in transit to market at the close of our fiscal year.

Average content of crude ore and concentrates of Judge Mining & Smelting Co., Utah, in 1918.

Kind of material.	Ore (dry).	Gold (per ton).	Silver (per ton).	Copper.	Lead.	Zinc.	Iron.	Value.
	Short tons.	*Fine ounce.*	*Fine ounces.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ton.*
Crude ore with residue mixed.	11,174	0.025	26.59	0.98	15.76	11.94	10.10	$33.10
Lead concentrate with residue mixed	8,002	.028	24.19	.88	28.50	10.66	18.03	49.41
Zinc dross	399					87.82		88.68
Zinc	1,310					99.90		203.41

TOOELE COUNTY.

Mine production in Tooele County, Utah, 1917–18.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	61	132,048	$32,344	793,265	4,181,231	15,031,521	1,306,974	$3,253,492
1918	51	102,305	23,703	691,175	2,531,769	14,197,551	517,600	2,395,353
Decrease, 1918		29,743	8,641	102,090	1,649,462	833,970	789,374	858,139

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[1] Daly West Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

[2] Judge Mining & Smelting Co. Ann. Rept. for year ending Dec. 31, 1918.

The production of 102,305 tons of ore by 51 producers in Tooele County in 1918 was 29,743 tons less than the output by 61 producers in 1917. The average value per ton of the ore decreased from $24.64 in 1917 to $23.41 in 1918, but the value per ton in gold and silver increased from $5.19 to $6.99. The total value of the ore sold or treated, containing gold, silver, copper, lead, and zinc was $2,395,353, against $3,253,492 in 1917.

Crude shipping ore of various kinds amounted to 54,113 tons. The zinc ore produced was 856 tons, all of which was of shipping grade and an oxidized product. The quantity of dry or siliceous ore increased from 263 tons in 1917 to 4,040 tons in 1918. The output of copper ore of shipping grade was 9,840 tons, nearly all of which was oxidized, and the lead ore was 41,154 tons, of which 12,592 tons was oxidized and 28,562 tons was sulphides. There was also 2,162 tons of copper-lead ore. The crude ore shipped directly to the smelters contained $20,904 in gold, 486,785 ounces of silver, 2,041,882 pounds of copper, 10,715,498 pounds of lead, and 517,600 pounds of recoverable zinc, having a total value of $1,819,936, or an average value per ton of $33.63. Concentrating and jigging plants produced 14,289 tons of concentrates from the treatment of 44,258 tons of ore and yielded $919 in gold, 164,314 ounces of silver, 489,887 pounds of copper, and 3,482,053 pounds of lead, valued in all at $533,461, or an average value per ton of $37.33.

Clifton or Gold Hill district.—Seventeen producers shipped 19,714 tons of ore in 1918, all of which, with the exception of 5 tons, was shipped directly to the smelters. The total output contained $9,293 in gold, 97,241 ounces of silver, 828,658 pounds of copper, and 1,204,472 pounds of lead, valued in all at $396,730, or an average value per ton of $20.12. Besides the Western Utah Copper Co., at Gold Hill, the largest shipper of copper ore and lead ore, the shippers were the Woodman (Frankie), Southern Confederate, Monoco, Copper Queen, Garrison Monster, and Copperopolis properties.

The geology of Gold Hill and vicinity was recently described by Kemp[1] as follows:

> The Gold Hill is the principal mine of the Clifton district and is shipping copper ore regularly to the smelter at Tooele. It is owned by the Western Utah Copper Co. The relation of the Gold Hill ore deposits to the general geological features of the district appears in the accompanying sketch. A rim of sedimentary rocks, mainly limestone, surrounds an inner basin of granite. To the north, at Dutch Mountain, and to the south, at Montezuma Peak, this rim rises to 8,000 feet or more. The granite itself forms no eminences, but residual fragments of its sedimentary cover stand up in irregular groups of hills. From the contacts now exposed it is evident that the intrusive top of the granite was nearly flat, and it is further apparent that the present erosion surface throughout the inner basin nearly coincides with this plane. The more deeply incisive valleys are all in granite, while the hilltops are always sedimentary rock. Gold Hill is the southern termination and highest point of a ridge of such sedimentary formation, which extends as an easterly dipping belt of well-defined limestones, quartzites, and shales from the east flank of Dutch Mountain for several miles to the southeast. The ridge is underlain by granite, which appears on both slopes, and it may be regarded as a roof pendant partly submerged in the intrusive rock. The ore bodies of the Gold Hill mine are found within the limestone member of the succession, at a point where it is most intricately cut and enveloped by the intrusive granite. They are not immediately associated with the contacts. Occasionally a contact will exhibit a little cupriferous pyrite intergrown with quartz, calcite,

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[1] Kemp, J. F., and Billingsley, Paul, Econ, Geology, June, 1918; Min. and Sci. Press, July 6, 1918, pp. 30–31.

and garnet, but much unprofitable prospecting has demonstrated the small extent and low value of such occurrences. The important mineralization is found entirely within the limestone, and consists, at present, of porous iron oxides, carrying copper and some lead in the form of carbonates. No sulphides whatever remain, desert climate and hilltop location combining to carry complete oxidation below any levels yet reached in the mine. In all probability the original mineralization was of pyrite, chalcopyrite, galena, and sphalerite. Thus the Gold Hill ore deposits fall within a familiar and important group, that of the pyritic replacements of limestone near a granite or monzonite contact, a group found at its widest development in the Warren district, Ariz. It is as representative of this group that the Gold Hill ore bodies are chiefly of interest, for in occurrence and mineralogy they have few unusual features.

Columbia district.—From the Old Sharp mine a small output of oxidized lead ore was shipped directly to the smelter.

Dugway district.—Some development was performed on several properties, and the Lucky Star Copper Co. made the only shipment of sulphide copper ore from its property in the district.

Erickson district.—The Tintic Delaware claim was worked, yielding lead sulphide ore, which was shipped directly to the smelter.

Free Coinage district.—From the Last Chance property lead ore, containing silver, was shipped to the smelter.

Lakeside district.—Two small shipments of ore were made from claims in the Lakeside district.

North Tintic district.—From the Scranton mine a large output of oxidized zinc ore and some oxidized lead ore was shipped to the smelters.

Ophir district.—Fifteen producers reported the output of 73,444 tons of ore, which included the shipment of 3,921 tons of old tailing. There was 43,758 tons of ore treated in concentration mills and 25,765 tons of ore shipped directly to smelters, which included 65 tons of zinc ore containing 38,586 pounds of recoverable zinc. The total output of the district contained $4,288 in gold, 512,702 ounces of silver, 1,669,363 pounds of copper, 9,135,999 pounds of lead, and 38,586 pounds of zinc, valued in all at $1,581,491. The principal producers were the Ophir Hill Consolidated, Hidden Treasure, Ophir Coalition, and Eureka Ophir. Small shipments were made from the Buffalo Consolidated, Surprise Tunnel, Kearsage, Thad Stevens, Mono, and Utah Queen.

Rush Valley district.—The district output of ore in 1918 amounted to 8,031 tons, of which 495 tons was concentrated and produced lead concentrate containing silver and a little copper. Altogether the ores produced yielded $8,939 in gold, 78,247 ounces of silver, 26,991 pounds of copper, 3,776,351 pounds of lead, and 23,089 pounds of zinc, valued in all at $364,075. The largest producer was the Bullion Coalition Co., which shipped crude ore directly to the smelters and treated a small quantity of ore that yielded a lead concentrate. The Keystone Development Co., operating several properties, shipped largely from the Galena King a good grade of lead ore containing silver and one lot of oxidized zinc ore. The other producers were the Calumet, Lookout, Muerbrook, Ben Harrison, and Southport properties.

Wild Cat Range district.—Silver ore and oxidized copper ore were shipped from the Silver Queen property to local smelters. This property also produced a high-grade fluorite, which was shipped to steel works near San Francisco.

UINTA COUNTY.

Carbonate district.—A small lot of copper ore was shipped from the Uinta claim.

UTAH COUNTY.

Fifteen operators in Utah County reported the production of 71,021 tons of ore in 1918, against 32,273 tons of ore produced by 16 operators in 1917. The total value of the output in 1918 was $2,439,585, against $1,064,457 in 1917. The total average value per ton of the ore increased from $32.98 in 1917 to $34.35 in 1918, and the gold and silver value per ton increased from $16.64 to $25.15. Most of the ore produced (52,159 tons) was of shipping grade, and the remainder (11,682 tons) was milled and produced concentrate containing gold, silver, copper, and lead. There was also 7,180 tons of ore containing gold, silver, and copper treated at the Silver City mill.

Mine production in American Fork district, Utah, 1917–18.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	7	3,610	$2,004	35,021	15,630	641,990	....	$90,339
1918	6	11,875	961	34,865	14,951	1,421,790	....	140,466
Increase or decrease, 1918	....	+8,265	−1,043	−156	−679	+779,800	....	+50,127
Total, 1870–1918	....	76,092	272,334	1,922,461	174,042	30,008,586	46,911	4,035,516

American Fork district.—Six operators in the American Fork district produced 11,875 tons of ore in 1918, valued at $140,466, or an average value per ton of $11.83. All the ore, except 193 tons shipped to smelters, was milled, and yielded lead concentrate containing silver and a little copper. Milling operations were performed principally on the ore of the Pacific property, which was worked by lessees during 1918. A new concentration mill of 50 tons daily capacity was started near the Belorophon property where some concentrate was recovered from ores treated from the Belorophon, Silver Wave, and Live Yankee properties, each operated by the American Fork Leasing Co. Lessees on the Miller property produced a small output of silver-bearing lead ore which was largely oxidized.

North Tintic district.—The Lehi Tintic property yielded in 1918 some oxidized lead ore, which was shipped directly to the smelter.

Tintic district.—The principal producer in 1918 was the Tintic Standard mine, followed by the Colorado Consolidated, Yankee, May Day, Uncle Sam, Sioux, Utah Consolidated, and Eureka Lily. The output of these properties is included in the table in the chapter on the Tintic district in Juab county.

WASHINGTON COUNTY.

Tutsagubet district.—From the Apex mine oxidized copper ore, carrying silver, was shipped directly to the smelter. All of this ore was hauled from St. George to Lund, from which point it was shipped to Salt Lake by railroad.

Bull Valley district.—Some gold specimens from a former producer were crushed and treated by amalgamation, and thus a small production of gold and silver was credited to the district in 1918.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN CALIFORNIA.

(MINES REPORT.)

By Charles G. Yale.

INTRODUCTION.

The outstanding feature of the metal-mining conditions in California in 1918 was the unprecedented decrease in the production of gold. For more than 70 years the State has usually led all others of the Union in annual output of gold, and its total production of the metal far exceeds that of all other States, but in 1918 all classes of mines producing gold showed a very material reduction in output as compared with 1917. This decrease was apparent not only in the mining of gold, but in the mining of all kinds of metals, a fact which shows that the decline was due entirely to conditions brought about by the war.

A careful study of the detailed returns which came into the San Francisco office of the United States Geological Survey reveals the fact that only to the extent of a few hundred thousand dollars has exhaustion of deposits influenced the decrease in the yield of gold. This exhaustion was limited almost entirely to fields exploited by dredging, and especially to two of the older larger dredging fields and a few smaller "outside" ones. The most extensive field, however, showed a material increase in yield, but not sufficient to offset the loss in other fields. From the nature of the gold-dredging industry, which works in surface deposits only, with definite areas as to boundaries and under predetermined average values to be obtained per cubic yard, there must be annually a certain exhaustion of the deposits, dependent on the capacity and activity of the gold-digging machinery. Moreover, it is but natural, on beginning work, as a matter of quick reimbursement of invested capital, that the best ground should be worked first so that in the older fields the machines are now digging on poorer ground than when they first began, with the result, of course, of smaller yields. Some of the dredges have worked out their available area of ground and have ceased work altogether or have been dismantled or moved to other districts where dredging ground is less circumscribed in area. In the smaller fields—outside of Yuba, Sacramento, and Butte counties—it does not pay to construct and operate the very large machines used where there is abundant gravel on which to work, so that the smaller machines, with less daily capacity, must necessarily have proportionately smaller production annually. The number of dredges operating therefore bears little relation to the total output of gold, as one of the huge steel machines of recent construction in the Yuba County field will dig more gravel in a day than half a dozen of the small machines in other districts.

The influence of the dredges on the gold-mining industry in California is paramount. This is evident from the fact that of the total gold produced in the State in 1918, 53 per cent came from the deep mines and 47 per cent from the placers, and of the total output of placer gold the dredges produced 95 per cent, or 45 per cent of the entire gold of the State. The yield from deep mines was 2 per cent less of the total in 1918 than in 1917 and that from all placers was 2 per cent more, which showed increased gains from the gravel mines. It is worthy of note that the siliceous ore from the deep quartz gold mines produced 95 per cent of the deep-mine gold and that the dredges produced exactly the same percentage of the placer gold. The total decrease in output of gold of the deep mines in 1918, as compared with 1917, was $2,323,300; the total decrease in placer gold was $1,235,251, of which the decrease from dredges was $881,600. So that the deficit was much more largely due to deep mines than to placer mines. The leading gold-producing county of the State, Yuba, is almost entirely a gravel-mining county; in this county are more and larger operating dredges than in any other county in the State and they produced nearly $100,000 more in gold in 1918 than in 1917, yielding altogether 99 per cent of the total output of the county. This gravel-mining county exceeded by $720,563 the output of deep-mine gold in Nevada County, which led the deep-mine gold producers of the State. Amador County, second in rank in total yield of gold in the State, only exceeded Nevada County through the work of one dredge operating within its borders, everything else practically being from deep mines.

For the entire State the production of the deep mines in 1918 decreased 21 per cent, whereas that of the placers decreased approximately 14 per cent.

It was almost entirely the war conditions which brought about this excessive deficit in the deep-mine gold industry. Very little loss is in evidence from exhaustion of ore deposits. Operation at some deep mines ceased entirely during 1918 because the low grade of the ores could not meet expenses under existing conditions, but these mines can be worked hereafter when costs are more normal. The few mines which were closed permanently were more than balanced by new enterprises which began operations. The real cause of the reduction in output of gold from deep mines was that many deep mines were only worked for two or three or six months, lying idle the rest of the time. Some worked steadily through the year with only one shift of men and all of them had to restrict operations, owing to lack of skilled labor. Such labor as was available was less efficient than usual, being mainly men either too young or too old, and much loss was due to this condition. It must be remembered also that few of the larger deep-mine gold producers were anxious to push production under costly conditions and pay resultant war income taxes. Their mines had to be kept in operation, but not necessarily up to capacity. Not only were costs of labor excessive but also costs of supplies, particularly of power, freight, machinery, and tools, and the cost of producing an ounce of gold was accordingly much more than it ever had been before. The president of a company owning one of the very largest deep gold mines in the State, having a gross output of more than $1,000,000, said in his annual report: "The conditions under which the business of gold mining was conducted during 1918 were so unfavorable and abnormal that the outcome affords no criterion of the results obtainable with ordinary factors of operation. The scarcity and inefficiency of labor and the high cost of all materials used, combined with a lower yield per ton crushed, resulted in a situation at the * * * mines during the latter part of the year when the cost of producing an ounce of gold exceeded the standard price at which it could be sold." It may be explained in this instance that the scarcity of labor made it necessary to mine the ore most readily available, without proper sorting, in order to keep the mill supplied. The opinion thus expressed as to cost of production of an ounce of gold is concurred in by the superintendents of a number of other highly productive mines, and the conditions were even worse at smaller mines, at which costs were proportionately larger.

In the five Mother Lode counties of the State, in one of which are the deepest gold mines, 60 per cent of the total ore milled in the State was treated. The output of ore in these counties fell off largely in 1918, but the average yield of the ore was about a dollar a ton higher than it had been for many years and most of this ore came from very deep workings. The value of all metals from ores of the State in 1918 gives an average of $9.32 a ton, as compared with $9.52 a ton in 1917. The ore milled and concentrated at gold and silver mills averaged $4.27 in gold and silver a ton, as compared with $4.46 a ton in 1917.

It is an interesting fact that under such adverse conditions in gold mining as existed in 1918, there should have been a large increase in the number of mines reporting production, especially when in the six preceding years there had been a steady decrease. There were, altogether, 213 more mines reporting production in 1918 than in 1917, of which 147 were deep mines and 66 were placers. The number of distinctively deep gold mines producing in 1918, however, was 260, which was 115 more than in 1917, and the number of all kinds of deep mines, gold, silver, copper, lead, and zinc, was 388 in 1918, or 147 more than in 1917, and from all of these more or less gold was obtained. Almost without exception the new producing properties were small deep mines and placers, yielding from a few hundred to a few thousand dollars each. This was due to conditions in the mining regions of the State, in mountain, foothill, and valley counties, where old miners and prospectors and others without steady occupation and not capable of regular industrial or war work turned to nomadic mining and prospecting in their respective localities. The gold was obtained in "crevicing," in bedrock in the small gulches, and from the river beds along the rivers, gulches, and creeks, river sands and small gravel bars being worked here and there where small spots yet unworked were found. Some gold was also obtained from small pocket seams and by "sniping" at one place and another. Because of the fact, also, that no annual assessment work had been required on mining claims in war times, hundreds of mines lay idle and without caretakers or watchmen and many of these were gouged or "gophered" for small quantities of the richer ore. In many of these mines a few tons of sulphurets had been piled up to await larger shipments and these small lots were gathered, further concentrated perhaps, and shipped for treatment at smelters and local refining works. A great many prospectors in the gold-mining counties also, gathered up considerable gold while prospecting. Old partly abandoned mills and reduction works sometimes afforded comparatively rich pickings. The gold-dust buyers, jewelers, country banks, and merchants buy the small lots thus obtained and the total, when finally deposited at the mint and smelters, amounts to a considerable sum.

While the deep mines of the State were undergoing a decline in output for the reasons before mentioned, the placers were generally hampered by a season of short water in almost all parts of California, which stopped the washing of gravel much earlier than usual and resulted in decreased output. The dredges also were more or less unfavorably influenced, as they were unable to obtain capable help on the boats and their periods of work were shortened by restrictions on power. At times they were only allowed a small part of the electric power needed for full-time work.

The other metals besides gold produced in the State were also adversely affected by the war conditions. The silver fell off 2 per cent in value, the copper 1 per cent in quantity and 10 per cent in value, the lead 39 per cent in quantity and 50 per cent in value, and the zinc 49 per cent in quantity and 54 per cent in value. The total combined value of all metals was $31,187,807, or 17 per cent less than in 1917.

It may be of interest to note the greatly decreased use of quicksilver for amalgamating the gold from the deep mines, owing to the greater use of other methods, notably cyaniding. No questions as to the quantity of quicksilver used is placer mining were asked of producers, and though these questions were asked from deep-mine operators, most of those who replied stated that they did not know or that no records had been kept. The answers were comparatively few for this reason. From such answers as were received, however, it was found that in the recovery of $4,265,293 in gold by both amalgamation and cyanidation 6,319 pounds of quicksilver was used for amalgamating gold valued at $2,888,629.

The quantity of quicksilver used per $1,000 recovered varied greatly in different mines. At the North Star mine, Grass Valley, one of the most prominent deep gold mines of the State, where the gold output was $775,688 from milling 99,550 tons of ore, 82.03 per cent of the gold was obtained in the mill by amalgamation and 17.97 per cent by cyanidation. Only a few exact statements of this kind are available.

The details of mining work in the Mother Lode counties are given in the section on production by counties. A condensed statement is given in the following table:

Gold and silver produced at mills in Mother Lode counties in California in 1918.

County.	Ore treated (short tons).	Gold and silver recovered in bullion.		
		Gold.	Silver (fine ounces).	Average value in gold and silver per ton of ore.
Amador	493,584	$1,911,858	20,494	$3.915
Calaveras	299,335	287,184	2,253	.967
Eldorado	707	16,141	142	23.031
Mariposa	37,116	305,486	3,537	8.326
Tuolumne	15,060	136,955	2,118	9.235
	845,802	2,657,624	28,544	3.176

County.	Concentrates produced.				Value of total recovery.	
	Quantity (short tons).	Gold.	Silver (fine ounces).	Average value in gold and silver per ton of concentrates.	Total.	Average value per ton of ore.
Amador	23,657	$1,050,436	7,407	$44.72	$2,990,195	$6.058
Calaveras [a]	19,980	398,274	5,286	20.20	692,997	1.613
Eldorado	....	....	....	....	16,283	23.031
Mariposa	668	30,542	1,524	48.00	341,089	9.190
Tuolumne [b]	3,290	135,203	19,221	46.94	293,497	5.396
	47,595	1,614,455	33,438	34.62	4,334,061	4.268

[a] Concentrates include those from 130,371 tons of ore sent direct to concentrating plants, which yielded 12,549 tons of concentrates.

[b] Concentrates include those from 39,336 tons of ore sent direct to concentrating plants, which yielded 5,229 tons of concentrates.

A comparison of this table with the corresponding one for 1917 shows a total decrease of ore treated at gold and silver mills in the five Mother Lode counties in 1918 of 391,101 tons. Each of these counties shows a decrease.

In the Mother Lode counties 845,802 tons of ore were treated in 1918 at gold and silver mills and 169,707 tons were treated at concentrating plants, and yielded in gold and silver $4,334,061, or an average of $4.268 per ton, as compared with 1,236,903 tons in 1917, yielding $5,130,682, or an average of $4.148 per ton, as compared with 1,393,788 tons in 1916, yielding $5,853,618 and averaging $4.199 a ton; with 1,521,847 tons in 1915, yielding $6,349,772 and averaging $4.17 a ton; 1,243,529 tons in 1914, yielding $5,075,522 and averaging $4.08 a ton; 1,242,343 tons in 1913, yielding $4,728,450 and averaging $3.81 a ton; and 1,299,988 tons in 1912, yielding $4,803,935 and averaging $3.69 a ton.

The average value of the gold and silver in the concentrates per ton was $34.62 in 1918, as compared with $40.35 in 1917 and with $56.83 in 1916. There were 47,595 tons of concentrates obtained from the 845,802 tons of siliceous milled ore, from 130,371 tons of copper ore concentrated by oil flotation into 12,549 tons of concentrates, and from 39,336 tons of siliceous ore directly concentrated in these counties in 1918.

The total quantity of ore treated at gold and silver mills from the deep mines of the State in 1918 was 1,414,644 short tons, which was 394,373 tons less than in 1917. Of the total ore milled (exclusive of ore sent to concentrating plants), 60 per cent came from the Mother Lode counties in 1918. Amador, the largest producer of ore and gold in the Mother Lode counties, produced about 35 per cent of the total quantity of ore milled in the State in 1918 and 58 per cent of the ore milled in the Mother Lode counties.

Crude ore sold or treated in California in 1918, in short tons.

County.	Siliceous ores.	Copper ores.	Lead ores.	Copper-lead ores.	Zinc ores.	Total.
Amador	516,476	39				516,515
Butte	196					196
Calaveras	319,752	167,751				487,503
Contra Costa		9				9
Del Norte		32				32
Eldorado	1,048	112				1,160
Imperial	20		42			62
Inyo	4,451	390	37,422	22	2,353	44,638
Kern	154,988	270				155,258
Madera	22	1,224				1,246
Mariposa	37,116	194				37,310
Marin		159				159
Merced		15				15
Modoc	600					600
Mono	1,898			5		1,903
Nevada	352,329					352,329
Placer	38,198	26				38,224
Plumas	9,067	293,826				302,893
Riverside		70	18			88
Sacramento	34					34
San Bernardino	5,170	14,704	1,264	270		21,408
San Luis Obispo		1,530				1,530
Shasta	24,486	420,298			14,996	459,780
Sierra	24,833					24,833
Siskiyou	3,313	1,993				5,306
Trinity	422	5,255				5,677
Tuolumne	44,529					44,529
Yuba	12	162				174
	[a] 1,538,960	908,059	38,746	297	17,349	2,503,411
Increase or decrease	−479,497	+15,480	−53,333	+297	+17,214	−499,839
Average value per ton in gold and silver	$5.533	$1.089	$13.705	$44.667	$2.237	$4.029

[a] Includes 2,729 tons of silver ore.

Value of ore mined and treated in California in 1918.

Class.	Ore (short tons).	Total value.		Average value per ton.	
		In gold and silver.	In all metals.	In gold and silver.	In all metals.
Siliceous	[a] 1,538,960	[b] $8,515,931	[c] $8,740,441	$5.533	$5.679
Copper	908,059	988,966	12,466,689	1.089	13.728
Lead	38,746	531,002	1,516,249	13.705	39.133
Copper-lead	297	13,266	36,923	44.667	124.320
Zinc	17,349	38,811	558,817	2.237	32.210
	2,503,411	10,087,976	23,319,119	4.029	9.315

[a] Includes 2,729 tons from silver ores.
[b] Includes $48,450 from silver ores.
[c] Includes $48,472 from silver ores.

The value of all metals obtained from ores mined and treated in California in 1918 (not including placer mine output) was $23,319,119, an average of $9.32 a ton. In 1917 the value was $28,589,495, an average of $9.52 a ton; in 1916 it was $31,154,122, an average of $9.77 a ton. In 1915 the figures, respectively, were $23,636,028 and $7.87 a ton; in 1914, $16,610,509 and $6.74; in 1913, $17,954,941 and $7.19; in 1912, $17,716,357 and $6.71; in 1911, $16,167,193 and $5.49; and in 1910, $18,109,008 and $6.71.

Gold and silver produced in California in 1918, by methods of treatment.

County.	Ore to gold and silver mills.			Ore to concentrating mills.	Concentrates produced.		
	Quantity.	Gold.	Silver.		Quantity.	Gold.	Silver.
	Short tons.		*Fine ounces.*	*Short tons.*	*Short tons.*		*Fine ozs.*
Amador	493,584	$1,911,858	20,494		23,657	$1,050,436	7,407
Butte	196	3,806	23				
Calaveras	299,335	287,184	2,253	130,371	19,980	398,274	5,286
Eldorado	707	16,141	142				
Imperial	20	206	2				
Inyo	4,447	8,352	74		70	10,482	2,810
Kern	154,962	241,876	5,556		86	1,488	180
Madera	22	165	7				
Mariposa	37,116	305,486	3,537		668	30,542	1,524
Modoc	600	7,000	20				
Mono	1,507	26,933	20,521				
Nevada	352,301	2,694,183	30,280		3,411	344,023	41,931
Placer	10,347	72,175	1,222		166	1,124	462
Plumas	8,905	58,122	362	292,504	22,086	37,744	149,568
Sacramento	34	3,411	29				
San Bernardino	4,051	1,425	13,774	80	315	18,832	11,223
San Luis Obispo				1,200	37	83	64
Shasta	2,920	41,439	1,409	132,428	18,107	4,357	41,217
Sierra	24,833	237,394	1,882		299	23,371	70
Siskiyou	3,313	40,509	401		50	4,258	37
Trinity	372	3,319	44		19	1,654	56
Tuolumne	15,060	136,955	2,118	29,336	3,290	135,203	19,221
Yuba	12	165	2				
	1,414,644	6,098,104	104,152	585,919	92,191	2,061,871	281,056
Average value per ton		$4.311	$0.073			$22.365	$3.049

County.	Crude ore to smelter.			Old tailings treated.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.		*Fine ounces.*	*Short tons.*		*Fine ounces.*
Amador	39	$21	39	22,892	$51,723	621
Calaveras	37,380	49,013	75,809	20,417	10,149	192
Contra Costa	9					
Del Norte	32					
Eldorado	444	4,858	541	9	108	1
Imperial	42	41	1,246			
Inyo	30,803	81,406	411,208	9,388		27,456
Kern	296	640	2,068			
Madera	1,224	7,418	4,199			
Mariposa	194					
Marin	159	62	1,074			
Merced	15	21	25			
Mono	5	8	1,171	391	4,311	1,035
Nevada				28	9,164	263
Placer	27,877	30,760	20,093			
Plumas	1,484	991	6,659			
Riverside	88	392	1,541			
San Bernardino	16,277	5,909	63,397	1,000	2,129	313
San Luis Obispo	330					
Shasta	324,415	254,116	375,979	17		16
Siskiyou	1,993	3,618	12,303			
Trinity	5,255	12,403	5,042	50	50	
Tuolumne				133	702	78
Yuba	162	186	225			
	448,523	451,863	982,619	54,325	78,336	29,975
Average value per ton		$1.007	$2.191		$1.442	$0.552

In 1918 there were treated at gold and silver mills and at concentrating plants 2,000,563 tons of ore yielding altogether $8,159,975 in gold and 385,208 fine ounces of silver, valued at $385,208, a total value of $8,545,183 in gold and silver, and an average value per ton of $4.27 in both metals. The average value in 1917 was $4.46; in 1916 was $5.04; in 1915, $5.56; in 1914, $5.44; in 1913, $5.57; in 1912, $5.08; in 1911, $4.64, and in 1910, $5.25.

There were recovered in 1918 as bullion in mills $6,098,104 in gold and 104,152 fine ounces of silver, valued at $104,152, a total of $6,202,256 in gold and silver, and an average per ton of $4.384 in both metals. From 1,414,644 tons of gold milling ore and 585,919 tons of concentrating ore, 92,191 tons of concentrates were obtained, containing $2,061,871 in gold and 281,056 fine ounces of silver, valued at $281,056. There was a yield of gold and silver of $2,342,927, or an average value of $25.41 a ton of concentrates.

Of the smelting ores 448,523 tons were treated having an output in gold of $451,863, and of 982,619 fine ounces of silver, valued at $982,619. The total yield of gold and silver was $1,434,482, or an average value of $3.20 a ton.

There were treated also 54,325 tons of tailings and slags, which yielded $78,336 in gold and 29,975 ounces of silver, valued at $29,975. The total gold and silver produced from slags and tailings was $108,311, an average of $1.994 a ton.

PRODUCTION.

GENERAL STATEMENT.

Gold, silver, copper, lead, and zinc produced in California, 1907–1918.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1907	1,061	2,054,653	$16,727,928	1,138,858	28,528,020	2,625,419	233,550	$23,338,104
1908	1,054	2,546,908	18,761,559	1,647,278	38,776,881	1,237,548	....	24,805,141
1909	1,127	3,041,688	20,237,870	2,098,253	57,288,281	1,502,597	....	28,841,050
1910	1,079	2,697,885	19,715,440	1,840,085	48,700,756	2,870,977	....	27,020,405
1911	1,181	2,797,261	19,738,908	1,270,445	36,316,136	1,398,111	2,807,035	25,174,677
1912	1,041	2,641,497	19,713,478	1,300,136	33,451,672	1,144,731	4,345,591	26,383,946
1913	796	2,495,958	20,406,958	1,378,399	34,575,007	3,514,342	1,057,485	26,812,487
1914	658	2,465,485	20,653,496	1,471,859	30,507,692	4,251,923	389,471	25,710,645
1915	608	3,002,779	22,442,296	1,678,756	40,751,625	4,579,245	13,094,032	32,263,844
1916	589	3,187,642	21,410,741	2,564,354	55,897,118	12,407,493	15,256,485	39,749,263
1917	490	3,003,250	20,087,504	1,775,431	48,153,139	21,868,628	10,872,716	37,685,985
1918	703	2,503,411	16,528,953	1,427,711	47,674,660	13,372,049	5,561,393	31,187,807
Increase or decrease, 1918	+213	−499,839	−3,558,551	−347,720	−478,479	−8,496,579	−5,311,323	−6,498,178

In 1918 there were 703 properties reporting production in California (213 more than in 1917), of which 388 were deep mines and 315 were placers. The production of deep mines in 1918 may be classified by chief metallic product as follows: Gold, 260; copper, 62; lead, 56; copper-lead, 6, and zinc, 4. Of the placer mines 113 were surface or sluicing, 43 more than in 1917; 87 were hydraulic, 16 more than in 1917; 66 were drift, 13 more than in 1917; and 49 were dredges, 6 less than in 1917. Of the deep mines there were 115 more gold mines, 14 more copper, 13 more lead mines, 6 more copper-lead mines (none in 1917), and 2 more zinc; there were, therefore, 147 more deep mines producing in 1918 than in 1917. The dredges are enumerated by the number of boats at work, some companies operating only one and others several.

Mine production of gold, silver, copper, lead, and zinc in California in 1918.

County.	Ore treated.	Deep-mine gold.		Placer gold.		Total gold.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ounces.*		*Fine ounces.*		*Fine ounces.*	
Amador	516,515	145,804.09	$3,014,038	11,384.91	$235,347	157,189.00	$3,249,385
Butte	196	184.12	3,806	31,064.93	642,169	31,249.05	645,975
Calaveras	487,503	36,020.99	744,620	6,126.35	126,643	42,147.34	871,263
Contra Costa	9	....	....	....	....	....	....
Del Norte	32	....	....	27.33	565	27.33	565
Eldorado	1,160	1,021.05	21,107	350.48	7,245	1,371.53	28,352
Fresno	....	....	....	231.96	4,795	231.96	4,795
Humboldt	....	....	....	388.36	8,028	388.36	8,028
Imperial	62	11.95	247	....	....	11.95	247
Inyo	44,638	4,849.11	100,240	....	....	4,849.11	100,240
Kern	155,258	11,803.69	244,004	102.70	2,123	11,906.39	246,127
Madera	1,246	366.83	7,583	....	....	366.83	7,583
Mariposa	37,310	16,255.36	336,028	80.01	1,654	16,335.37	337,682
Marin	159	3.00	62	....	....	3.00	62
Merced, San Joaquin, and Stanislaus [a]	15	1.02	21	10,933.13	226,008	10,934.15	226,029
Modoc	600	338.63	7,000	....	....	338.63	7,000
Mono	1,903	1,511.82	31,252	....	....	1,511.82	31,252
Nevada	352 329	147,416.52	3,047,370	1,116.64	23,083	148,533.16	3,070,453
Placer	38,224	5,033.84	104,059	6,101.59	126,131	11,135.43	230,190
Plumas	302,893	4,685.46	96,857	1,371.43	28,350	6,056.89	125,207
Riverside	88	18.96	392	....	....	18.96	392
Sacramento	34	165.01	3,411	81,817.27	1,691,313	81,982.28	1,694,724
San Bernardino	21,408	1,368.77	28,295	44.99	930	1,413.76	29,225
San Luis Obispo	1,530	4.02	83	....	....	4.02	83
Shasta	459,780	14,508.24	299,912	11,784.00	243,597	26,292.24	543,509
Sierra	24,833	12,614.51	260,765	1,383.67	28,603	13,998.18	289,368
Siskiyou	5,306	2,340.62	48,385	11,892.61	245,842	14,233.23	294,227
Trinity	5,677	842.98	17,426	20,670.78	427,303	21,513.76	444,729
Tuolumne	44,529	13,199.60	272,860	71.01	1,468	13,270.61	274,328
Yuba	174	16.98	351	182,256.78	3,767,582	182,273.76	3,767,933
	2,503,411	420,387.17	8,690,174	379,200.93	7,838,779	799,588.10	16,528,953
Total, 1917	3,003,250	532,776.80	11,013,474	438,956.20	9,074,030	971,733.00	20,087,504
Increase or decrease	−499,839	−112,389.63	−2,323,300	−59,755.27	−1,235,251	−172,144.90	−3,558,551

County.	Deep-mine silver.		Placer silver.		Total silver.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*		*Fine ounces.*	
Amador	28,561	$28,561	1,029	$1,029	29,590	$29,590
Butte	23	23	2,387	2,387	2,410	2,410
Calaveras	83,540	83,540	610	610	84,150	84,150
Contra Costa	....	....	....	....	....	....
Del Norte	....	....	4	4	4	4
Eldorado	684	684	38	38	722	722
Fresno	....	....	37	37	37	37
Humboldt	....	....	72	72	72	72
Imperial	1,248	1,248	....	....	1,248	1,248
Inyo	441,548	441,548	....	....	441,548	441,548
Kern	7,804	7,804	13	13	7,817	7,817
Madera	4,206	4,206	....	....	4,206	4,206
Mariposa	5,061	5,061	22	22	5,083	5,083
Marin	1,074	1,074	....	....	1,074	1,074
Merced, San Joaquin, and Stanislaus [a]	25	25	1,120	1,120	1,145	1,145
Modoc	20	20	....	....	20	20
Mono	22,727	22,727	....	....	22,727	22,727
Nevada	72,474	72,474	83	83	72,557	72,557
Placer	21,777	21,777	655	655	22,432	22,432
Plumas	156,589	156,589	161	161	156,750	156,750
Riverside	1,541	1,541	....	....	1,541	1,541

[a] Yield of single mine in each county combined to avoid disclosing separate output.

Mine production of gold, silver, copper, lead, etc.—Continued.

County.	Deep-mine silver.		Placer silver.		Total silver.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*		*Fine ounces.*	
Sacramento	29	$29	4,608	$4,608	4,637	$4,637
San Bernardino	88,707	88,707	5	5	88,712	88,712
San Luis Obispo	64	64	....	....	64	64
Shasta	418,621	418,621	1,789	1,789	420,410	420,410
Sierra	1,952	1,952	169	169	2,121	2,121
Siskiyou	12,741	12,741	1,760	1,760	14,501	14,501
Trinity	5,142	5,142	1,770	1,770	6,912	6,912
Tuolumne	21,417	21,417	8	8	21,425	21,425
Yuba	227	227	13,569	13,569	13,796	13,796
	1,397,802	1,397,802	29,909	29,909	1,427,711	1,427,711
Total, 1917	1,748,174	1,440,495	27,257	22,460	1,775,431	1,462,955
Increase or decrease	−350,372	−42,693	+2,652	+7,449	−347,720	−35,244

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Amador	3,789	$936	....	....	....	....	$3,279,911
Butte	....	....	....	....	....	....	648,385
Calaveras	6,936,549	1,713,328	....	....	....	....	2,668,741
Contra Costa	5,910	1,460	....	....	....	....	1,460
Del Norte	10,219	2,524	....	....	....	....	3,093
Eldorado	20,262	5,005	....	....	....	....	34,079
Fresno	....	....	....	....	....	....	4,832
Humboldt	....	....	....	....	....	....	8,100
Imperial	....	....	23,999	$1,704	....	....	3,199
Inyo	445,349	110,001	12,110,453	859,842	2,512,877	$228,672	1,740,303
Kern	95,834	23,671	....	....	....	....	277,615
Madera	227,758	56,256	....	....	....	....	68,045
Mariposa	27,264	6,734	630	45	....	....	349,544
Marin	22,629	5,589	....	....	....	....	6,725
Merced, San Joaquin, and Stanislaus[a]	2,064	510	....	....	....	....	227,684
Modoc	....	....	....	....	....	....	7,020
Mono	466	115	945	67	....	....	54,161
Nevada	10,546	2,605	32,626	2,316	....	....	3,147,931
Placer	838,365	207,076	....	....	....	....	459,698
Plumas	11,191,743	2,764,361	....	....	....	....	3,046,318
Riverside	11,493	2,839	19,636	1,394	....	....	6,166
Sacramento	....	....	....	....	....	....	1,699,361
San Bernardino	1,350,728	333,630	631,930	44,867	2,824	257	496,691
San Luis Obispo	67,850	16,759	....	....	....	....	16,906
Shasta	25,029,899	6,182,385	551,830	39,180	3,045,692	277,158	7,462,642
Sierra	....	....	....	....	....	....	291,489
Siskiyou	573,435	141,638	....	....	....	....	450,366
Trinity	774,620	191,331	....	....	....	....	642,972
Tuolumne	....	....	....	....	....	....	295,753
Yuba	27,888	6,888	....	....	....	....	3,788,617
	47,674,660	11,775,641	13,372,049	949,415	5,561,393	506,087	31,187,807
Total, 1917	48,153,139	13,145,807	21,868,628	1,880,702	10,872,716	1,109,017	37,685,985
Increase or decrease	−478,479	−1,370,166	−8,496,579	−931,287	−5,311,323	−602,930	−6,498,178

[a] Yield of single mine in each county combined to avoid disclosing single output.

GOLD.

The total mine production of gold in California in 1918 was 799,588.10 fine ounces, valued at $16,528,953, a decrease of 172,144.90 fine ounces, valued at $3,558.551. The deep mines of the State yielded 420,387.17 fine ounces of gold, valued at $8,690,174, which was a decrease of 112,389.63 fine ounces in quantity and of $2,323,300 in value. Of the deep-mine gold 95 per cent was derived from siliceous ore, 4 per cent from copper ore, and 1 per cent from lead ore.

As shown above, there was a material decrease in the output of gold from deep mines in 1918, as compared with 1917. There was also a decrease in yield of placer mine gold of 59,755.27 fine ounces in quantity and of $1,235,251 in value. The dredges yielded $881,600 less gold in 1918 than in 1917. Since gold dredging began in California in 1898, the total output of gold from that source to the end of 1918 has been $102,618,912. Since 1898 the Oroville (Butte County) dredging field has yielded $30,687,986, not including $2,338,816 derived in the last nine years from adjacent districts in the same county. The Marysville (Yuba County) field produced from 1903 to 1918, inclusive, $31,869,100 in gold; the Folsom (Sacramento County) field has produced since 1902 by dredging gold valued at $23,525,954. The output of the dredges operating in numerous other fields in the State is not included in these figures of the more extended dredge fields. The placer yield of gold in 1918 in California was 379,200.93 fine ounces, valued at $7,838,779. The placer mines produced 47 per cent of the gold yield in 1918, and the deep mines 53 per cent, as compared with 45 per cent for the placers in 1917 and 55 per cent for the deep mines. The dredges produced 45 per cent of the total gold yield from all sources in 1918. Of the total placer gold, the dredges produced 95 per cent, the hydraulic mines 3 per cent, the drift mines 1 per cent, and the sluicing mines 1 per cent. It is probable that this percentage from surface placers is too high, for in the reports received at the office of the United States Geological Survey numbers of mines classify themselves as working placers without specifying the exact kind. Some of these may have been small hydraulic or drift mines instead of mere surface or sluicing mines. Although the larger and more important dredging fields of the State are at Oroville, in Butte County; Folsom, in Sacramento County; and Marysville, in Yuba County, dredges are also operated in nine other counties—1 in Amador, 2 in Calaveras, 1 in Merced, 2 in Placer, 1 in San Joaquin, 4 in Shasta, 3 in Siskiyou, 1 in Stanislaus, and 4 in Trinity. The Yuba County dredges, 12 in number, made the largest output of gold in 1918, the value being $3,750,033, an increase of $90,822, compared with 1917. Sacramento County with 10 dredges at work made an output of $1,690,279, a decrease of $223,225 in gold output. In Butte County (including Oroville and the "outside districts"), eight dredges produced $626,010, or $267,131 less than in 1917.

Of the 32 counties producing gold in 1918 in California, 9 yielded no placer gold, and 6 yielded no gold from deep mines. Four counties produced more than $1,000,000 each in gold in 1918, as follows: Yuba, $3,767,933; Amador, $3,249,385; Nevada, $3,070,453; and Sacramento, $1,694,724. The leading hydraulic mining county was Trinity; the largest producer of gold from surface or sluicing placers was Butte; and the largest producer of gold from dredges was Yuba County. The largest increase ($90,260) in gold in 1918 was from Yuba County, which was followed by San Joaquin ($70,744; there was none from this county in 1917), Mariposa ($24,386), and Modoc. The counties which showed a decreased output of gold in 1918, as compared with 1917, were as follows: Nevada, $612,494; Calaveras, $600,179; Amador, $414,779; Placer, $308,496; Kern, $291,725; Butte, $276,296; Shasta, $231,616; Sacramento, $224,857; Trinity, $157,319; San Bernardino, $127,751; Sierra, $95,060; Stanislaus, $66,519;

Tuolumne, $46,757; Merced, $33,392; Siskiyou, $31,323; Inyo, $25,154; Humboldt, $15,058; Madera, $11,331; and Plumas, $6,748.

Mine production of gold in California in 1918, in fine ounces.

County.	Placers.	Deep mines.						Grand total.
		Siliceous ores.	Copper ores.	Lead ores.	Copper-lead ores.	Zinc ores.	Total	
Amador	11,384.91	145,803.07	1.02				145,804.09	157,189.00
Butte	31,064.93	184.12					184.12	31,249.05
Calaveras	6,126.35	33,514.97	2,506.02				36,020.99	42,147.34
Del Norte	27.33							27.33
Eldorado	350.48	1,021.05					1,021.05	1,371.53
Fresno	231.96							231.96
Humboldt	388.36							388.36
Imperial		9.97		1.98			11.95	11.95
Inyo		911.10		3,920.84	17.17		4,849.11	4,849.11
Kern	102.70	11,795.71	7.98				11,803.69	11,906.39
Madera		7.98	358.85				366.83	366.83
Mariposa	80.01	16,255.36					16,255.36	16,335.37
Marin			3.00				3.00	3.00
Merced, San Joaquin and Stanislaus [a]	10,933.13		1.02				1.02	10,934.15
Modoc		338.63					338.63	338.63
Mono		1,511.43			.39		1,511.82	1,511.82
Nevada	1,116.64	147,416.52					147,416.52	148,533.16
Placer	6,101.59	5,033.84					5,033.84	11,135.43
Plumas	1,371.43	2,816.64	1,868.82				4,685.46	6,056.89
Riverside			16.98	1.98			18.96	18.96
Sacramento	81,817.27	165.01					165.01	81,982.28
San Bernardino	44.99	1,084.90	215.90	63.95	4.02		1,368.77	1,413.76
San Luis Obispo			4.02				4.02	4.02
Shasta	11,784.00	4,811.62	9,676.35			20.27	14,508.24	26,292.24
Sierra	1,383.67	12,614.51					12,614.51	13,998.18
Siskiyou	11,892.61	2,165.60	175.02				2,340.62	14,233.23
Trinity	20,670.78	242.99	599.99				842.98	21,513.76
Tuolumne	71.01	13,199.60					13,199.60	13,270.61
Yuba	182,256.78	7.98	9.00				16.98	182,273.76
	379,200.93	[b]400,912.60	15,443.97	3,988.75	21.58	20.27	420,387.17	799,588.10
Total 1917	438,956.20	[c]495,588.33	32,402.01	[d]4,786.46			532,776.80	971,733.00
Increase or decrease	−59,755.27	−94,675.73	−16,958.04	−797.71	+21.58	+20.27	−112,389.63	−172,144.90

[a] Yield of single mine in each county combined to avoid disclosing separate output.
[b] Includes 43.93 ounces from silver ores.
[c] Includes 6.97 ounces classed as from silver ores in 1917.
[d] Includes 4,663.44 ounces classed as from silver-lead ores in 1917.

Value and source of placer gold mined in California in 1918.

County.	Hydraulic.	Dredging.	Drift.	Surface placers.	Total.
Amador		$223,836	$1,530	$9,981	$235,347
Butte		626,010	4,394	11,765	642,169
Calaveras		111,305	4,627	10,711	126,643
Del Norte	$565				565
Eldorado			4,289	2,956	7,245
Fresno				4,795	4,795
Humboldt	7,636			392	8,028
Kern				2,123	2,123
Mariposa				1,654	1,654
Merced, San Joaquin, and Stanislaus [a]		225,858		150	226,008
Nevada	21,670		763	650	23,083
Placer	3,810	46,360	66,276	9,685	126,131
Plumas	18,402		4,589	5,359	28,350
Sacramento		1,690,279	1,034		1,691,313
San Bernardino				930	930
Shasta		238,802		4,795	243,597
Sierra	13,037		11,682	3,884	28,603
Siskiyou	60,488	181,882		3,472	245,842
Trinity	87,621	337,562	244	1,876	427,303
Tuolumne			1,323	145	1,468
Yuba		3,750,033	7,669	9,880	3,767,582
	213,229	7,431,927	108,420	85,203	7,838,779

[a] Yield of single dredge in each county combined to avoid disclosing separate output.

From the siliceous ore and tailings the recovery of gold by methods of treatment in California in 1918 was as follows: By amalgamation, 283,293.09 fine ounces, valued at $5,856,188; by cyanidation, 46,289.60 fine ounces, valued at $956,891; by chlorination, 5,769.83 fine ounces, valued at $119,173; from concentrates and ore sent to smelters for treatment, 63,199.95 fine ounces, valued at $1,306,459. These figures are only approximate, as many small operators keep no separate accounts, and even the larger companies do not always segregate the quantity of gold obtained by methods of treatment. This is especially the case where larger mills amalgamate in the batteries and on the plates and pass the tailings and concentrates direct to the cyanide plants. The recovery of some of the gold is due to the use of the flotation system, but this has not been considered in the above segregation of methods of treatment of the ore.

The 315 productive placer mines in California in 1918 yielded gold valued at $7,838,779, and 29,909 ounces of silver, valued at $29,909, a total of $7,868,688. The decrease in placer gold was $1,235,251, and the increase in value of silver was $7,449. In production of gold the dredge properties showed a decrease of $881,600, the hydraulic mines a decrease of $53,874, the drift mines a decrease of $258,339, and the surface or sluicing mines a decrease of $41,438.

SILVER.

The deep mine production of silver in California in 1918 was 1,397,802 ounces, valued at $1,397,802, a decrease in quantity of 350,372 ounces and in value of $42,693. The larger portion of the output, 982,619 fine ounces, valued at $982,619, was derived from crude smelting ore. Siliceous ore, milled and smelted, yielded 228,332 ounces. The largest output of silver in 1918 came from Inyo County (not from Shasta as has been usual for years), which produced from copper ores 960 ounces; from siliceous ore, 3,456 ounces; from lead ores, 433,242 ounces; and from copper-lead ores, 3,890 ounces. This makes a total yield of silver from Inyo County of 441,548 ounces, valued at $441,548. Shasta County followed Inyo in yield of silver, the output being 420,410 ounces, valued at $420,410, as compared with 631,921 ounces in quantity and $520,703 in value in 1917. The total silver derived from deep mines of all classes and from placer mines in California in 1918 was 1,427,711 ounces, valued at $1,427,711. The silver obtained from refining placer gold mined in the State in 1918 was 29,909 ounces. The largest producer of placer silver was Yuba County—13,569 ounces.

From 1,538,960 tons of siliceous ore in 1918 was derived 228,332 fine ounces of silver; from 908,059 tons of copper ore, 669,711 ounces of silver; from lead ores, 448,547 ounces of silver; from copper-lead ores, 12,820 ounces of silver; and from zinc ores, 38,392 ounces of silver.

Mine production of silver in California in 1918, by sources, in fine ounces.

County.	Placers.	Deep mines.						Grand total.
		Siliceous ores.	Copper ores.	Lead ores.	Copper-lead ores.	Zinc ores.	Total.	
Amador	1,029	28,522	39				28,561	29,590
Butte	2,387	23					23	2,410
Calaveras	610	5,837	77,703				83,540	84,150
Del Norte	4							4
Eldorado	38	283	401				684	722
Fresno	37							37
Humboldt	72							72
Imperial		2		1,246			1,248	1,248
Inyo		3,456	960	433,242	3,890		441,548	441,548
Kern	13	5,981	1,823				7,807,804	7,817
Madera		7	4,199				4,206	4,206
Mariposa	22	5,061					5,061	5,083
Marin			1,074				1,074	1,074
Merced, San Joaquin, and Stanislaus[a]	1,120		25				25	1,145
Modoc		20					20	20
Mono		21,556			1,171		22,727	22,727
Nevada	83	72,474					72,474	72,557
Placer	655	21,777					21,777	22,432
Plumas	161	1,552	155,037				156,589	156,750
Riverside			10	1,531			1,541	1,541
Sacramento	4,608	29					29	4,637
San Bernardino	5	28,107	40,313	12,528	7,759		88,707	88,712
San Luis Obispo			64				64	64
Shasta	1,789	9,736	370,493			38,392	418,621	420,410
Sierra	169	1,952					1,952	2,121
Siskiyou	1,760	438	12,303				12,741	14,501
Trinity	1,770	100	5,042				5,142	6,912
Tuolumne	8	21,417					21,417	21,425
Yuba	13,569	2	225				227	13,796
	29,909	[b] 228,332	669,711	448,547	12,820	38,392	1,307,802	1,427,711
Total, 1917	27,257	[c] 147,870	882,480	[d]717,796		28	1,748,174	1,775,431
Increase or decrease	+2,652	+80,462	−212,769	−269,249	+12,820	+38,364	−350,372	−347,720

[a] Yield of single mine in each county combined to avoid disclosing separate output.
[b] Includes 47,452 ounces classed as from silver ores.
[c] Includes 8,378 ounces classed as from silver ores in 1917.
[d] Includes 552,641 ounces classed as from silver-lead ores in 1917.

From the siliceous ore and old tailings treated in California in 1918, the recovery of silver by amalgamation was 71,103 fine ounces; by cyanidation, 60,870 ounces; by chlorination, 3,631 ounces; and from concentrates sent to smelters 92,728 ounces. From smelting ores silver was recovered amounting to 1,169,470 ounces, and from placer mines 29,909 ounces of silver was recovered.

COPPER.

The mine production of copper in California in 1918 was 47,674,660 pounds, valued at $11,775,641, a decrease of 478,479 pounds in quantity and of $1,370,166 in value from the production in 1917. Copper was produced in Amador, Calaveras, Contra Costa, Del Norte, Eldorado, Inyo, Kern, Madera, Mariposa, Marin, Merced, Mono, Nevada, Placer, Plumas, Riverside, San Bernardino, San Luis Obispo, Shasta, Siskiyou, Trinity, and Yuba counties. The largest production came as usual from Shasta County, which produced 25,029,899 pounds, valued at $6,182,385, a decrease of 1,628,980 pounds in quantity and of $1,095,489 in value, as compared with 1917. Altogether, in the State, there were 908,059 tons of copper ore treated in 1918, 15,480 tons more than in 1917. The smelting plant of the Mammoth Copper Co., at Kennett, Shasta County, is the most extensive in the State. It not only handles its own copper ores but those of some other large copper-producing mines in the county. The Mountain Copper Co., Keswick, Shasta County, ships ores and concentrates from its mines 250 miles by rail to its smelter at Martinez, on San Francisco Bay. The ore of the Engels Copper mine and Walker Mining Co., in Plumas County, is concentrated by the flotation process and the concentrates are shipped to Salt Lake City, Utah. The Calaveras Copper Co., Calaveras County, also concentrates its ores by flotation and ships concentrates to smelters. The Penn Mining Co., Calaveras County, has a 200-ton smelter and ships blister copper. A number of smaller mines in other counties having no reduction works of their own ship their ores or concentrates to smelters. The copper ores of California in 1918 yielded, in addition to the copper, 15,443.97 fine ounces of gold, valued at $319,255, and 669,711 ounces of silver, valued at $669,711.

LEAD.

The mine production of lead in California in 1918 was 13,372,049 pounds, valued at $949,415, as compared with 21,868,628 pounds, valued at $1,880,702, in 1917. From lead ore was obtained also 3,988.75 fine ounces of gold, valued at $82,455, and 448,547 fine ounces of silver, valued at $448,547. The total value of the output from the lead-mining industry in the State in 1918 in lead and contained value of gold and silver was $1,480,417, as compared with $1,129,811 in 1917. This refers to ores classified as lead ores only.

ZINC.

The mine production of recoverable zinc in California in 1918 was 5,561,393 pounds, valued at $506,087, as compared with 10,872,716 pounds, valued at $1,109,017, in 1917, a decrease for 1918 of 5,311,323 pounds in quantity and of $602,930 in value. The zinc output of the State in 1918 was from the counties of Shasta, Inyo, and San Bernardino in the order named.

PRODUCTION BY COUNTIES.

AMADOR COUNTY.

Amador County continued in 1918 to lead all the other counties of California in quantity of ore produced and treated 516,515 tons, exceeding the next county in rank, Calaveras, by 29,012 tons. The reduction in quantity in 1918 amounted to 288,360 tons as compared with 1917. The gold produced in Amador County in 1918 was valued at $3,249,385, the silver at $29,590, and the copper at $936. There were 31 producing deep mines in the county in 1918 and 9 placers.

Of the total output of ore 39 tons of copper ore were shipped to smelters and 493,584 tons were treated at gold and silver mills. From this milling ore $1,911,858 in gold and 20,494 ounces of silver were saved as bullion, and 23,657 tons of concentrates were obtained which yielded $1,050,436 in gold and 7,407 ounces in silver, valued at $7,407. The value of the total gold and silver from milling ore was $2,990,195, or $6.058 a ton. The 22,892 tons of old tailings retreated yielded $51,723 in gold and $621 in silver, a total if $52,344. The ore shipped to the smelter yielded $21 in gold and $39 in silver, in addition to the copper. The placer gold produced in the county in 1918 was valued at $235,347, which was $229,190 more than in 1917. This largely increased output of gold was due to the yield from dredging operations, from which no gold was recovered in 1917. Amador was in 1918 the second gold-producing county in the State, with $3,249,385 to its credit, thus exceeding Nevada County in rank but being itself exceeded by Yuba County.

There are 10 producing mines in and around Amador City, four of them important. The Bunker Hill Consolidated property is opened by an incline shaft of 2,900 feet and by drifts 2,600 and 2,800 feet in length. In 1918 about 1,400 feet of shaft work was done, 3,387 feet of drifts and crosscuts, and 381 feet of raises. The equipment consists of a 40-stamp mill, ball mill, and 24 Frue vanners. The property was only operated at partial capacity during 1918. The tailings were treated by the Darrow Leasing Co. The Keystone Mines property is opened through a 2,800-foot incline shaft. The mine, which was operated continuously during 1918, is equipped with a 40-stamp amalgamation and concentration mill. The concentrates were shipped to a smelter for treatment but the tailings were not treated. The Treasure Mining Co. has a 150-ton ball-mill plant for amalgamating and concentrating. The mine is opened through an incline shaft 1,600 feet deep and an incline winze. Among other deep mine producers is the Original Amador Consolidated and several smaller properties. The Fremont Consolidated Mining Co., at Drytown, includes the Gover, North Gover, Loyal Lode, and Fremont mines, which have all been worked as one property. The high costs of operation, together with the lower grade ore worked, caused a permanent closing of these properties in October, 1918; the mines have filled with water and the machinery and mill have been sold. Only a few small gold and copper mines were operated near Ione during the year.

Some of the most productive of the Mother Lode mines in the State are operated in and around Jackson and Sutter Creek. The Argonaut, at Jackson, is opened by an inclined shaft 4,700 feet deep, with numerous drifts, crosscuts, and winzes. There is a 60-stamp amalgamating and concentrating mill on the property and the concentrates were shipped to a smelter for treatment. The mine was in operation 350 days in 1918. The California Slimes Concentrating Co. treats the slimes coming from the Argonaut mill. The Kennedy Mining & Milling Co. has a vertical shaft 4,155 feet in depth, which is the deepest gold-mine shaft in California, if not in the United States. The company sunk 143 feet on it in 1918. The reduction plant consists of a 100-stamp amalgamating and concentrating mill and chlorination works for treating the concentrates—one of the few in the State. The mine and mill were operated through the year. At Sutter Creek the Central Eureka is developed by an incline shaft 3,600 feet deep with more than 30,000 feet of drifts and crosscuts on 36 levels. Approximately 2,000 feet of development work was done in 1918. The plant consists of a 40-stamp amalgamation and concentration mill. The concentrates were shipped to a smelter, but the tailings were not treated. The ore milled in 1918 was extracted below the 3,000-foot level. The pumping plant of the South Eureka was operated by this company for the benefit of both mines during the cessation of operations by the South Eureka mines. Only a few small quartz mines are operated near Pine Grove and Volcano. The extensive mine and plant of the Plymouth Consolidated Gold Mines (Ltd.), operated by English capital, were worked continuously during the year 1918. Twelve levels have been opened from the combination vertical and incline shaft. The ore treatment in the 360-ton amalgamation and concentration mill is by stamping, Hardinge mills, amalgamation, classification, rough concentration, fine concentration, with regrinding tailings and amalgamation of the tailings. The concentrates are shipped to the Selby smelter.

Among the placer mines in operation in this county in 1918 were the Byrne, at Amador City; Pigeon Drift, at Oleta; China Hill, Elephant, and Garibaldi Gravel, at Volcano. There is also one dredge of the American Gold Dredging Co. operating in Amador County on Mokelumne River, which constitutes the boundary line between Amador and Calaveras counties in that section.

BUTTE COUNTY.

In 1918 25 mines reported production from Butte County. Only 196 tons of ore from deep mines was treated in the county, which yielded $3,806 in gold and $23 in silver. The total output of gold was $645,975, a decrease of $276,296, as compared with 1917. The 8 dredges in the county recovered gold valued at $626,010, which was $267,131 less than 11 dredges produced in 1917. The number of dredges operating in the county was 3 less than in 1917, several having worked out their available ground and ceased operations. The 6 drift mines of the county produced $4,394 in 1918, or $9,590 less than in 1917. The 7 sluicing or surface placers produced $11,765 in 1918, as compared with $10,490 in 1917, an increase of $1,275. The total gold output from placers of all kinds was $642,169, or $275,446 less than in 1917. Butte County, formerly the leading producer for many years of dredge gold, was third in rank in 1918 in this respect, being exceeded by Yuba and Sacramento counties, as was the case in 1917.

In 1918 the Oroville district proper yielded from the operations of 6 dredges $527,410, which was $190,372 less than in 1917. The following table shows the output of gold from the Oroville dredging field for several years, with the annual increase or decrease:

Mine production of gold in Oroville dredging district, Calif., 1903–1918, with increase or decrease, by years.

Year.	Production.	Increase or decrease.	Year.	Production.	Increase or decrease.
1903	$1,329,998	....	1911	$1,987,294	−$112,334
1904	1,632,507	+$302,509	1912	2,080,229	+ 92,935
1905	2,261,887	+ 629,380	1913	1,918,050	− 162,179
1906	2,768,782	+ 506,895	1914	1,422,407	− 495,643
1907	2,697,092	− 71,630	1915	1,171,315	− 251,092
1908	3,043,151	+ 346,059	1916	970,409	− 200,906
1909	2,743,232	− 299,919	1917	717,782	− 252,627
1910	2,099,628	− 643,604	1918	527,410	− 190,372

The combined dredges in the fields outside of Oroville, in Butte County, yielded in gold $98,600, as compared with $175,359 in 1917, a decrease of $76,759.

In 1918 the following companies were operating in the Oroville field; Natomas Co. of California (3 dredges), Oroville Dredging Co. (Ltd.) (2), and American Gold Dredge Co. (1). The Oroville Dredging Co. (Ltd.), operated from January to August, when both dredges closed down permanently, the available ground being exhausted.

The Pacific Dredging Co. operated two dredges in outside districts.

Other placers worked in the county were at Bangor, Cherokee, Coutolenc, De Sabla, Enterprise, Magalia, Nimshew, Oroville, and Stirling City. These were either sluicing or drift mines.

CALAVERAS COUNTY.

Calaveras, one of the Mother Lode counties, had a production of 487,503 tons of ore in 1918, a decrease from 1917 of 109,321 tons. The total yield of gold for the county in 1918 was $871,263, a decrease of $600,179, which is the largest decrease in gold in any county in the State. This decrease was partly due to the almost entire cessation of operation at two large deep-mine properties and the curtailment of work in others but mainly due to the loss in production of gold by dredges of $388,480 in 1918, as compared with 1917. Several dredges worked out their available ground and stopped operations permanently. The value of the silver output of the county in 1918 was $84,150, or $3,834 less than in 1917. The copper output in 1918 was 6,936,549 pounds, valued at $1,713,328, as compared with 8,052,978 pounds, valued at $2,198,463, a decrease in quantity of 1,116,429 pounds, and in value of $485,135. In 1918 producing mines to the number of 41 reported, of which 19 were placers and 22 were deep mines. Of the deep mines there were 18 gold and 4 copper mines. The placers consisted of 2 dredges (3 less than in 1917), and 4 drift and 13 surface mines. From the placers, gold recovered by dredges in 1918 amounted to $111,305, a decrease of $388,480, as compared with 1917; that from the drift mines was $4,627, or $7,751 less than in 1917; and that from surface placers was $10,711, or $5,306 more than in 1917. The average value per ton of 299,335 tons of milling ore treated at gold and silver mills in the county in 1918 was $1.613 in gold and silver, compared with $2.35 in 1917. This was by far the lowest average value per ton in the Mother Lode counties and was, as stated, lower than in 1917, and greatly reduced the average value per ton of the five Mother Lode counties. The quantity of ore sold or treated in Calaveras County in 1918 was 487,503 tons, which yielded gold valued at $744,620; silver valued at $83,540; and 6,936,549 pounds of copper, valued at $1,713,328. The placer output was $126,643 in gold and $610 in silver. The output of the county in 1918 in gold, silver, and copper was $2,668,741.

There were 299,335 tons of ore treated at gold and silver mills, from which were obtained $287,184 in gold in bullion and $2,253 in silver. The total value in bullion was $289,437, or $0.967 a ton. From the 299,335 tons of ore directly milled and 130,371 tons of ore sent to concentrating plants were obtained 19,980 tons of concentrates yielding $398,274 in gold and 5,286 ounces of silver, an average in gold and silver of $20.20 a ton. The recovery of copper from the ore concentrated was 3,535,655 pounds. There were 37,380 tons of smelting ore sold or treated yielding $49,013 in gold and 75,809 fine ounces of silver, or $3.34 a ton in gold and silver, and 3,400,894 pounds of copper. The total value of the smelting ore was $964,843, or $25.80 a ton. In addition there were treated 20,417 tons of old tailings yielding $10,149 in gold and 192 ounces of silver, or an average of $0.51 a ton.

The Angels Quartz Mining Co., at Angels, was operated the first few months of 1918 and was then closed down. The Utica Mining Co., at the same place, operated the full year. This property is worked by incline shaft, drifting, crosscutting, and stoping by the pillar system. It is equipped with a 40-stamp amalgamation and concentration mill. The Penn Mining Co., at Campo Seco, owns the most productive copper mine in the county, which also yields considerable gold and silver. The mine is opened by an incline shaft 2,900 feet deep. It is equipped with a 150-ton reverberatory smelter which treats crude ore. The blister copper is shipped to the American Metal Co., New York City. The Calaveras Copper Co., at Copperopolis, treats its ore by oil flotation and the concentrates are sintered and shipped to the smelter at Tacoma, Wash. The ore treated contains no gold, silver, lead, or zinc. The Carson Hill Gold Mines Co., at Carson or Melones Hill, operates the property formerly owned by the Morgan Mining Co., which has been dissolved. The mine is operated by two incline shafts, 720 and 550 feet deep, respectively, and four adits, the longest one of which is 2,160 feet, and 800 feet of drifts and crosscuts. The equipment consists of a 20-stamp and a 3-stamp mill. The ore treatment consists of coarse crushing with stamps, fine grinding in Hardinge mills, flotation concentration, and cleaning concentrates on tables. The concentrate is handled by Simonds & Latham, at Melones. The Melones Mining Co., at Melones, is opened through an adit 5,000 feet long, incline winze 2,000 feet deep, and a secondary incline winze below bottom level, 500 feet deep. The equipment consists of a 100-stamp mill for amalgamation and concentration, and sand, slime, and sulphuret cyanide plants. The ore is amalgamated and concentrated, the sand and slime classified on Wilfley tables, the sands being leached by cyanide, the slime cyanided in a continuous agitation plant, and the sulphurets reground and cyanided. The ores are sulphide, the oxidized ore having been entirely worked out. The property was operated throughout the year on a small scale, owing to labor shortage and high costs. The Napoleon copper mine, at Milton, is opened by a 250-foot vertical shaft. The crude ore was treated in a 50-ton oil flotation plant, the concentrates and some crude ore being shipped to Tacoma, Wash. The mine was operated the entire year. The Quail Mining Co. has a productive copper mine at Milton. The Pacific Gold & Milling Co., at Mokelumne Hill, has its property opened by a 315-foot shaft, a 300-foot adit, and 3,000 feet of drifts. During 1918 the company did 175 feet of sinking and 413 feet of drifting and raising. The company has a 100-ton mill, ball mill for amalgamation, and the concentrates are caught on tables and vanners. The concentrates are shipped to the Selby smelting plant. The mine was operated throughout the year and the mill for nine months. After some production the Duntley Cotton Mines Co. closed in September, 1918.

The Sheep Ranch group, at Sheep Ranch, an old mine reopened, has an incline shaft 1,300 feet, with a 225-foot winze on the 1,300-foot level, 1,400-foot drift at bottom, and approximately the same length of levels at 100-foot intervals to surface. The property has a 20-stamp mill for amalgamation only. Work was prosecuted in this mine throughout 1918. The first months were devoted to unwatering the mine and sampling. This was completed in April. The remainder of the year development work was carried on and the mill ran intermittently from June to the end of December. Other quartz mines producing in a smaller way are the Finnegan, Stockholders Mining Co., Horse, Phillips, and Glory.

Only two dredges were in operation in Calaveras County in 1918, whereas there were five in 1917. The operating dredges in 1918 were the American Gold Dredge Co., at Camanche, and the Ivy L. Borden, at Jenny Lind. There are small placers of various kinds at Angels, Camanche, Esmeralda, Mokelumne Hill, Mountain Ranch, Railroad Flat, San Andreas, Sheep Ranch, and Valley Spring. Except the dredges no placer mines make any notable production.

DEL NORTE AND HUMBOLDT COUNTIES.

The only deep mine operated productively in Del Norte County was that of the Salt Lake-California Copper Co., at Smith River, which yielded copper ore, carrying no gold or silver. Two small placers at Crescent City, the Myrtle Creek and the Musick, made some output of gold and silver. The total output of this county in 1918 was valued at $3,093.

In Humboldt County no deep mines reported an output in 1918, and the producing placers were all at or near Orleans. These were mainly hydraulic mines and a few minor surface placers. The principal placer mines in this county are the Pearch, Bowlder, Elkhorn, and California Mining Syndicate. The total output of this county in 1918 was $8,100 in gold and silver.

ELDORADO COUNTY.

Eldorado is one of the five Mother Lode counties of California, but its mining activities are not so great as formerly and no extensive deep mining operations are now being conducted in the county. The placer mines also are less productive and very much less in number than in the past.

The output of gold of the county in 1918 was $28,352, as compared with $24,758 in 1917, and that of the silver was valued at $722, as compared with $85 in 1917. There were 1,160 tons of ore produced by 14 deep mines, each of which showed only a small tonnage. Of these two are copper mines. The deep mines produced $21,107 in gold, $684 in silver, and 20,262 pounds of copper, valued at $5,005, a total value of $26,796 for 1918.

The placer mines of the county yielded $7,245 in gold and 38 ounces of silver, valued at $38, as compared with $19,158 in gold and 69 ounces of silver, valued at $57, in 1917. Twenty-three mines (14 deep mines and 9 placers) in the county reported production, as compared with 14 mines in 1917.

The Copper Hill mine, which produced most of the copper, is the old Cosumnes Copper Co.'s mine at Fairplay. The Rosencranz gold mine is at Garden Valley. The Blue Rock mine, at Georgetown, was worked by four men on a percentage basis by stoping out quartz seams and crushing the rock with spring pole and mortar. The mine later became idle. The Golden State, at Georgetown, was worked in a small way as "seam diggings" for pockets. A little open-cut work was done on the Morning Star at the same place. The Wolf and Buckeye mine was worked on a small scale, the sorted ore being hand-mortared. At Placerville a small quantity of gold came from the Fessier, Holly, and Manzanita mines; and some gold was produced by the Anderson, at Rescue; the Griffin, at Shingle; and the Le Bars pocket mine, at Spring Garden.

Of the placers the Rocky Bar sluicing mine is at Fairplay. At Georgetown are the Jackson, Pacific, and several smaller mines. The only others of any importance are the Rising Hope, at Placerville, and the Benefeldt and Fort Jim, at Smith Flat. There are also some small placers at Omo Ranch and Shingle.

INYO COUNTY.

In 1918 there were 61 producing deep mines in Inyo County. Of these mines 7 were gold, 7 copper, 41 lead, 3 copper-lead, and 3 zinc. The total value of the metallic output for the year was $1,740,303, or $1,216,366 less than in 1917. The value of the gold was $100,240, or $25,154 less than in 1917. The silver amounted to 441,548 ounces, valued at $441,548, making this county the first in rank of output of silver in the State and displacing for the second time in many years Shasta as the leading silver county. The decrease in the value of silver in Inyo County in 1918, as compared with 1917, was $93,051. The output of copper in 1918 was 445,349 pounds, valued at $110,001, a decrease in quantity of 292,233 pounds and in value of $91,359. The output of lead in the county was 12,110,453 pounds, valued at $859,842, as compared with 19,671,732 pounds, valued at $1,691,769 in 1917, a decrease in quantity of 7,561,279 pounds and in value of $831,927. The production of zinc in 1918 was 2,512,877 pounds, valued at $228,672, a decrease of 1,443,466 pounds, as compared with 1917.

There were sold or treated in 1917 in Inyo County 44,638 tons of ore, of which 4,451 tons were siliceous ore, 390 tons copper ore, 37,422 tons lead ore, 22 tons copper-lead ore, and 2,353 tons zinc ore. The deep mines in 1918 yielded gold valued at $100,240 and 441,548 ounces of silver. Of the gold, 911.10 fine ounces, valued at $18,834, were obtained from siliceous ore, $81,051 from lead ore, and $355 from copper-lead ore. The production of silver from siliceous ore was 3,456 fine ounces, from copper ores 960 ounces, from lead ores 433,242 ounces, and from copper-lead ores 3,890 ounces. The siliceous ore yielded $22,290 in gold and silver, the copper ores $960, the lead ores $514,293, and the copper-lead ores $4,245, a total of $541,788 in gold and silver.

At Ballarat the Big Horn is working a lead carbonate ore carrying some silver. The ore is shipped to Utah for reduction. The Base Metals Mining Co., at Big Pine, also ships its lead ore, carrying gold and silver, to Salt Lake smelters. The Biddell Bros. mine produced a small quantity of shipping ore. The Never Rest Mining Co. rebuilt its mill, which consists of a 50-ton Hardinge ball mill and a concentrator. After making an experimental run of 30 days, it was found necessary to put in a cyanide plant to obtain the gold and silver content of the ores. The Index Mining Co. (Roberts mines) made only a nominal output. The Montezuma silver-lead mine was quite a large producer, mainly of lead, but also of gold, silver, and copper. The Empire Lead Mining Co. owns the Red Bird, Empire, and Fausel mines, and ships its ore to a smelter. The Probstiel, Stirle, and Whittier are small shippers of lead ore. The total output in all metals of these mines in and near Big Pine was valued at $54,331. From Bishop only small shipments were made by a few mines. The Argus Sterling, at Darwin, shipped considerable copper ore to Salt Lake smelters. The Blue Bell & Blue Bell Fraction has a 5-stamp amalgamation and concentration mill and treats its tailings by cyaniding. The Christmas Gift ships mainly lead ore which carries considerable silver and also some gold and copper. The Columbia mine of the Darwin Lead & Silver Mines Development Corporation is a small producer of lead-silver ore. The Defiance mine, leased by the same corporation, is a large producer of both lead and silver, with some gold. The Custer Mining Co. made only small shipments of lead-silver ore. One of the larger producers at Darwin is the Darwin Lead & Silver Development Corporation, which worked its own property in addition to those leased and previously mentioned. The output of lead and silver was large and there was also some gold and copper recovered from the ore shipped to smelters. The Inyo Silver & Lead Smelting Co. shipped lead-silver ores carrying some gold and copper, as did the Mineatta Mines Co. and the Promontory, the latter of which was under lease to the Darwin Lead & Silver Mines Development Corporation. The Utacala Exploration Co. (Towser mine) shipped zinc ores exclusively and was the most productive mine in the Darwin district. The Seaman also shipped zinc ore. The total value of the output of the mines in and near Darwin, including lead, silver, zinc, gold, and copper, amounted in 1918 to $336,086. From Independence the smaller shippers were the Mary Roper copper mine, Johnson & Williams copper mine, Johnson & Vollmer copper mine, and Hunter lead-silver mine. The Independence mine, a lead-silver producer, was under lease to the Darwin Lead & Silver Mines Development Corporation. The most productive property in the county is that of the Cerro Gordo Mines Co., at Keeler, mainly worked for lead but also producing largely silver and zinc with some gold. This property is opened through a 900-foot vertical shaft, with drifts, crosscuts, winzes, and tunnels. There is no reduction plant; the lead ore is shipped to Midvale, Utah, and the zinc ore to the Empire Zinc Co. The mine was operated for the entire year 1918, but the lower prices for lead and zinc in 1918 than in 1917 and the much higher prices for labor, supplies, and freight, caused operations generally to be somewhat restricted. Arrangements have been made for a milling plant for the local treatment of the low-grade ores in the mine. Among smaller shippers from Keeler were the Berryhill, Hall, McDonald, Pennsylvania, San Lucas, Shafer, Stockton, Ventura Mining Co., and Wigginton. The

Ella group shipped considerable lead and silver ore. A very large shipper of lead-silver ore was the Santa Rosa Lead & Silver Mining Co., although all the work done in 1918 was by lessees, the ore being shipped to Midvale, Utah. The Western Metals Mining Co. (Ingomar mine) produced zinc ores exclusively and the ore carried no silver or gold. The total output in all metals of the ore mined at or near Keeler was valued at $708,109. From Lone Pine shipments were made from the Nellie H. (five claims) and the Tom Boy. The mine of the Reward Gold Mines Co., at Owenyo, is developed by 8,000 feet of adits and drifts, and is equipped with an 80-ton amalgamation, concentration, and flotation plant. As operating costs had advanced more than 60 per cent, work was stopped for the year at the beginning of April. At Tecopa by far the largest producer is the Tecopa Consolidated Mining Co., which owns a well-developed property having a 75-ton concentrating mill installed but not running in 1918. The crude ore was shipped to the Murray and Midvale smelters. Other producers at Tecopa were the Madison lead mine, McCabe lead mine, and Speculator group of copper mines. Shipping from Trona railroad station are a number of mines which haul their ore to that point in auto trucks. The Ophir produces lead-silver ore and ships to the smelter at Midvale, Utah. The Weir & Ball ships from Trona. The Slate Range Minerals Co. is a very large producer of lead, silver, gold, and a little copper. This mine is opened by a vertical shaft 130 feet deep and two adits 450 and 900 feet in length, respectively. Two thousand feet of drifts and 900 feet of adits and winzes were cut in 1918. Mr. John E. Curran writes that none of the 15 patented claims at Panamint have been worked for years. Other claims have also been developed but have shipped no ore. The Tuba Canyon (Salvage group) mine near Trona has two 3-stamp triple-discharge Merrill batteries and a 25-ton cyanide plant, the last installed in 1918. The mine was worked only two months in 1918. The Ubehebe Lead Mining Co.'s property, under lease to J. H. Crook, shipped its ore to the International Smelting Co. The mine was only operated for three months in 1918.

KERN COUNTY.

Twenty-one deep mines and three placers reported production from Kern County in 1918. The total metallic output of the county decreased from $616,645 in 1917 to $277,615 in 1918, a decrease of $339,030. The total production of gold was $246,127 in 1918, as compared with $537,852 in 1917, a decrease of $291,725. The silver output in 1918 was 7,817 fine ounces, valued at $7,817, as compared with 9,482 ounces valued at $7,813 in 1917. Copper to the amount of 95,834 pounds, valued at $23,671, was produced in 1918, as compared with 260,000 pounds, valued at $70,980 in 1917. This was a decrease in quantity of 164,166 pounds and in value of $47,309.

There were treated or sold 155,258 tons of ore in 1918, of which 154,988 tons was siliceous ore and 270 tons copper ore. A total of 154,962 tons were sent to gold and silver mills and 296 tons to the smelters. The yield in bullion from the ore treated at gold and silver mills was $241,876 in gold and 5,556 fine ounces of silver, a total bullion value of $247,432 in gold and silver, and an average value per ton of $1.60. There were 36 tons of concentrates, with a value of $1,488 in gold and 180 ounces of silver, derived from this ore. From the 296 tons of ore sent to smelters there was obtained $2,708 in gold and silver, or an average of $9.14 a ton. In addition, the 296 tons of ore sent to the smelters yielded 95,834 pounds of copper. The total yield of the county in gold, silver, and copper from the deep mines was $275,479, an average of $1.77 a ton. The three surface placer mines of the county yielded $2,123 in gold and 13 fine ounces of silver.

The Glen Olive mine, at Bodfish, is equipped with a 10-stamp mill and recovered all its gold by amalgamation. The Mammoth Mountain, at Isabella, is equipped with a 10-stamp amalgamation and concentration mill, but the mine was only worked at intervals from January to August, 1918. The Keyes Mining & Milling Co., which has a 5-stamp amalgamation mill, spent most of the year in renovating its mine; hence it had a comparatively small output. The Shipsey Mining Co.'s mine, Johannesburg, is opened by a 450-foot incline shaft and 1,000 feet of drifts; it has a 5-stamp amalgamation mill and was operated the entire year. The Discovery, or Double Standard group of mines, at Mohave, is opened by a 230-foot vertical shaft and an adit 700 feet long; it has a small 5-stamp concentration mill. The Eckis and Wegman are small gold mines at Mohave. The Way, at Piute, only made a small trial run on some of its ore. The Gwynne is opened by a 1,500-foot tunnel and two winzes of 160 and 300 feet, respectively. It has a 3-stamp amalgamation and concentration mill and was only worked in a desultory manner by lessees in 1918. At Randsburg, the principal camp in the county, the Arizona made a small output, as did the Butte mines, which worked only one month in 1918. The Butte Lode Leasing Co. permanently ceased operations in November, 1918, as the superintendent wrote that "each dollar recovered costs $2.50 to produce." This was the result of three years' steady work. The Yellow Aster Mining & Milling Co., the largest mine in Kern County, has its mine opened by an incline shaft of 550 feet and a vertical shaft of 350 feet, as well as an adit 4,000 feet in length and 5,000 feet of drifts. No real development was accomplished in 1918, owing to the high price of labor and supplies. The equipment consists of a 100-stamp amalgamation mill and a large crushing and screening plant, with conveyor belts. The company tried to work the very low-grade ore through the new crushing and screening plant until July 1, but could not make it pay under prevailing costs. On July 1 all but 30 stamps were hung up, and they were run on a better grade of ore, but as that did not pay the mine was shut down on December 31. In January, 1919, sinking in the incline shaft was begun under changed management. The unprofitable attempt to work very low-grade ore in this mine accounts for the very low average yield per ton of the total ores of the county, as 93 per cent of the ore mined in the county is derived from this mine. The Tropico Mining & Milling Co., at Rosamond, is opened by a 600-foot vertical shaft and 3,700 feet of drifts. The ore is milled in a 10-stamp amalgamation mill, and the tailings are cyanided. The Blue Mountain Mining Co. is operated at White River on the border of Tulare County. The Weringer is a copper producer at Woody.

MADERA COUNTY.

Madera County in 1918 produced a total of $68,045 in value of metals, as compared with $135,128 in 1917, a decrease of $67,083. The 1,246 tons of ore treated or sold yielded $7,583 in gold; 4,206 fine ounces of silver, valued at $4,206; and 227,758 pounds of copper, valued at $56,256, a total of $68,045. Two deep gold mines and 5 copper mines reported production in 1918.

At Jesebel the Vignola and Bagnella mines each made a small output of copper. The Florence claims, at O'Neals, are merely prospects having a nominal yield of gold. The Willow Creek has a new 5-stamp mill and concentrator and was only "sampled" during the war, owing to high cost of fuel and labor. The most productive property in the county was the Buchanan copper mine, under control of the Mammoth plant of the United States Smelting, Refining & Mining Co., of Shasta County, to which the ores were shipped. The Erskine is a small copper producer, shipping from Raymond. The ore of the Madera Gold Mining Co. (Daulton mine) has its values mainly in copper, but with material quantities of gold and silver.

MARIPOSA COUNTY.

Mariposa, which is one of the Mother Lode counties of California, showed an increase of $23,062 in the value of its total metallic output in 1918, as compared with 1917. The total value in 1918 was $349,544; in 1917 it was $326,482. Twenty-two of the 26 mines reporting production in 1918 were deep mines. The output of ore decreased by 4,566 tons. The output of gold was $337,682 in 1918, as compared with $313,296 in 1917, an increase of $24,386. The silver output decreased 1,174 ounces and the copper decreased 9,238 pounds.

The deep mines of the county produced 37,310 tons of ore, of which 194 tons went to the smelters. The 37,116 tons of ore which went to the gold and silver mills yielded $305,486 in gold as bullion, and 3,537 ounces of silver, valued at $3,537, the total gold and silver value of bullion being $309,023, or an average value of $8.33 a ton. From this ore were derived 668 tons of concentrates, which yielded $30,542 in gold and 1,524 ounces of silver, a total value of $32,066. The yield of the concentrates is thus shown to have been $48 in gold and silver a ton. A small quantity of copper ore, which carried no gold or silver, was shipped to a smelter and yielded 26,592 pounds of copper, an average value per ton of $33.86. The siliceous ore yielded on the plates and from the concentrates a total value of $341,089 in gold and silver, an average value per ton of $9.19.

Small quantities of gold came from the Jacobson, Lasch, and other small mines at Bagby and Briceburg. At Coulterville the Champion Mining Co., Murphy, Merced Mining Co. (Malvinia), Sain, and Storey & Budd properties made small outputs of gold. The White Gulch Mining Co., near Coulterville, one of the larger producers in the county, is developed by a 300-foot adit, a 700-foot incline shaft, and about 7,000 feet of drifts, crosscuts, and raises. The equipment consists of crushers, and a 10-stamp amalgamation and concentration mill. The concentrates were shipped to the Selby smelter and the tailings were not treated. The mine was operated with two shifts the entire year, and the mill was run 242 days. The Original Mining & Milling Co., at El Portal, produced a large output of gold and a small quantity of silver. The mine was operated for seven months in 1918. The Ruth Pierce Mining Co. is the most important enterprise at Hornitos and was operated about half time in 1918. The equipment consists of a 10-stamp mill and 2 Frue concentrators. Other productive mines at Hornitos were the Anderson copper mine, the Silver-Lead, and sundry smaller properties. The Early, at Jerseydale, has an Ellis ball mill of 20 tons capacity. The mine was operated the entire year. The Marble Springs and Trujillo were small producers at Kingsley, as were the Colorado and James mines at Mariposa. The entire output from the mines of the Mariposa Commercial & Mining Co. was obtained by lessees and pocket hunters, as the company operated no mines on its own account. The Mountain King Mining Co., at Mountain King, was the most productive mine in the county in 1918. It is opened by a 740-foot vertical shaft, an adit 985 feet long, and 740 feet of drifts, and crosscuts. The reduction equipment consists of a 30-stamp amalgamation and concentration mill, the concentrates being shipped to the Selby smelter for treatment. The mine was operated full time the entire year. The Green Mountain (Copper Queen) mines made shipments of copper to the Mammoth smelter from Raymond.

A few small surface placers were worked at Hornitos and Mariposa and yielded a total of $1,676 in gold and silver by sluicing.

MONO COUNTY.

The total value of the metal output in Mono County decreased from $214,702 in 1917 to $54,161 in 1918, a decrease of $160,541. The decrease in gold was $177,788. The silver output increased from 6,871 fine ounces, valued at $5,662, in 1917, to 22,727 ounces, valued at $22,727, in 1918.

There were 1,507 tons of crude ore treated at gold and silver mills, which yielded $26,933 in gold and 20,521 fine ounces of silver, valued at $20,521, a total of $47,454, or an average value of $31.49 a ton in gold and silver. The average value of this ore per ton in gold and silver in 1917 was $11.48. No concentrates were reported. There were 391 tons of old tailings treated, which yielded $5,346 in gold and silver, or an average of $13.67 a ton, as compared with the average value in 1917 of $10.22 a ton. The total value of the 1,898 tons of ore and tailings was therefore $52,800 in gold and silver, or an average value of $27.82 a ton, as compared with the average value in 1917 of $11.43 a ton.

At Benton the Blind Spring Hill, Silver Reef, and McLean mines were small producers. At Bodie the only producer reporting was the Standard mine. The property was not operated by the owners in 1918, but several leases were let in different parts of the mine and some tailings were treated by cyanidation. Some gold and silver were also recovered from the mill and the mill-yard clean-up. The Nevada Progressive Gold Mining Co., at Masonic, has a 35-ton concentrating and cyaniding plant, the cyanide plant having been installed during 1918. The Serita Mining Co., also at Masonic, was operated for only a short time during 1918 but made a material output of gold and some silver.

NEVADA COUNTY.

Nevada County was third in rank among gold-producing counties of California in 1918, being displaced as the leading county in this respect by Yuba. It was, however, one of the three counties which exceeded a three million dollar output of gold in 1918, the total yield of gold having been $3,070,453, as compared with $3,767,933 from Yuba County and $3,249,385 from Amador County. The decrease of total output of gold in Nevada County in 1918, as compared with 1917, was $612,494, which was the largest decrease in any county in the State. The production of gold from deep mines decreased $619,207; that of the placers increased $6,713. The average value per ton of ore treated in gold and silver mills in this county was $8.62, as compared with $10 in 1917 and $8.95 in 1916.

The quantity of ore and tailings treated in the county in 1918 was 352,329 short tons. There were 26 producing mines that reported, of which 19 were deep or quartz gold mines and 7 were placers. The hydraulic mines produced in gold $21,670, the drift mines $763, and the surface placers $650, a total value of $23,083 from the placers. The deep mines produced gold valued at $3,047,370 and silver valued at $72,474, a total of $3,119,844.

There were 352,301 tons of siliceous ore treated at gold and silver mills. The value of the gold in the mill bullion was $2,694,183, an average value of $7.65 a ton, and the silver output from the same source was 30,280 fine ounces, valued at $30,280, or about 9 cents a ton. The total value of the gold and silver recovered in the mill bullion was $2,724,463, an average value of $7.73 a ton. From the milling ore there were obtained 3,411 tons of concentrates which carried $344,023 in gold and 41,931 ounces of silver, valued at $41,931. The total value of the concentrates was $385,954 in gold and silver, or an average value of $113.15 a ton. From the 352,301 tons of milling ore there was recovered from both bullion and concentrates $3,038,206 in gold and 72,211 ounces of silver, valued at $72,211. The total value of the gold and silver recovered from bullion and concentrates was $3,110,417, the average value per ton being $8.83 in gold and silver. There were 28 tons of slag (tailings) treated, yielding $9,164 in gold and 263 ounces of silver.

The Eureka mine, at Graniteville, has a 5-stamp mill and the property was operated from January to August, 1918. The Republic made a nominal output only. At Grass Valley, the principal center of mining operations in the county, the Brunswick Consolidated Gold Mining Co. has its property opened by a 1,550-foot vertical shaft, a 1,250-foot incline shaft, and several miles of drifts. There are two 20-stamp amalgamation and concentration mills. The property was operated during 1918 until June 1, at which date all mine operations were suspended indefinitely. The Central Consolidated Mining Co., which has a 20-stamp mill, was not operated to any extent in 1918. The Golden Center of Grass Valley Mining Co. has a mine which is opened by a 1,100-foot inclined shaft and has a 20-stamp mill with 5 Frue concentrators. The mine was run continuously throughout the year. The Grass Valley Consolidated Gold Mines (Allison Ranch mine), recently reopened, has an inclined shaft 1,675 feet deep, and a 20-stamp amalgamation and concentration mill on the property. The North Star Mines, one of the largest deep-mine gold producers of the State, was operated continuously during the year, although at reduced capacity and at a loss, due to shortage of labor. The mine is opened by a 6,300-foot incline shaft, tapped by 1,600-foot vertical shaft. Only 700 feet of development work was accomplished during 1918. The equipment consists of a 60-stamp amalgamation and concentration mill and a 300-ton cyanide plant. The ore is treated by stamp crushing and amalgamation and the concentrates are ground in tube mills and cyanided. The mill tailings are cyanided direct; sand percolation and slime agitation are used. A plant has been constructed for the disposal of tailings to prevent them from going into drainage channels. The ore milled gave an average yield of $7.79 a ton crushed, at an average cost of $7.20 a ton for operating and $0.09 a ton for development expenses, an aggregate cost of $7.29 per ton crushed ($5.59 per ton mined) and leaving a realized profit of 50 cents per ton milled. The yield per ton crushed in 1918 was $3.64 less than in 1917. The decrease was partly due to unfavorable working conditions, the scarcity of labor making it necessary to mine the ore most readily available, without proper sorting, in order to keep the mill supplied, and partly to the fact that the North Star vein so far as developed below the 4,000-foot level seems to be of poorer and less uniform quality than in the upper levels. An absence of bunches of rich rock is noticeable. Of the total production for the year 82.03 per cent was obtained in the mill by amalgamation, and 18 per cent was recovered by cyanidation. The loss in tailings was about 33 cents per ton of one crushed. The Sultana Gold Mining Co. did nothing but development work during 1918, with a nominal output. The Union Hill mines are opened by a 1,200-foot incline shaft. Some 3,300 feet of development work was done in 1918, with only a small output. Scheelite was found in this mine below the 600-foot level. The mine is equipped with a 20-stamp amalgamation and concentration mill. The most productive deep quartz gold mine in the State is operated at Grass Valley, but the owner declines to give any information concerning it. This is the only operator of an important mine in the State of which this is true.

The principal group of mines at Nevada City is the Champion mines, owned and operated by the North Star Mines Co., of Grass Valley. The mine and plant were in operation during the entire year. The mine is opened by an incline shaft 2,700 feet deep. The plant consists of a 180-ton amalgamation and concentration mill and a 188-ton cyanide plant. The sands, slimes, and concentrates are cyanided. The total output for the year was $271,108. The ore milled realized $6.56 a ton, resulting in a small profit over all expenses. The ore nearly all came from the Providence mine and further prospecting is continued. The result of the Champion venture of the North Star Mines Co. has been very disappointing. From 1911 to the end of 1918 a total of 228,810 tons of ore has been milled with an average yield of $5.44 a ton, while the cost of operation and development per ton has been $8.04. The production obtained has been only about 6 tons of ore per foot of development, compared with 20 to 25 tons per foot at the North Star at Grass Valley.

More than 10,000 pounds of copper and 32,000 pounds of lead were obtained from certain ore found in the Champion mines in 1918, a very unusual circumstance in that district. The Zeibright mine, at Nevada City, was worked for about eight months during 1918. It is opened by an adit 1,350 feet long, to which 325 feet were added in 1918. The equipment consists of a 10-stamp mill and ball mill, with capacity of 50 tons in 24 hours. The tailings are allowed to go to waste at present. There are a few other quartz mines in operation at this place, most of them, however, having only small outputs of gold. The Gaston Gold Mining Co., at Washington, had to close down, owing to scarcity of labor.

There are in Nevada County seven productive placer mines, of which three are hydraulic, two sluice, and two drift mines. The principal ones are that of the California Placer Mines Co., at You Bet, and the Omega, at Washington, both hydraulic mines. Other placers operated were the French, at French Corral, Grizzly Ridge, at North Columbia, and smaller mines at French Corral, North Bloomfield, and North San Juan.

PLACER COUNTY.

The gold and silver produced in Placer County in 1918 was valued at $252,622, as compared with $552,571 in 1917, a decrease of $299,949 in gold and silver. The total yield of gold was $230,190 and that of silver was 22,432 fine ounces, valued at $22,432.

The deep mines produced from 38,224 tons of ore gold valued at $104,059; 21,777 fine ounces of silver, valued at $21,777; and 838,365 pounds of copper, valued at $207,076. The placer mine yield was $126,131 in gold and 655 ounces of silver, valued at $655, a total of $126,786. The yield from placer mines was $292,972 less in gold and silver in 1918 than in 1917. The decrease in gold from deep mines was $16,226. The total metallic output of the county in 1918 was valued at $459,698, a decrease of $265,886, as compared with 1917. There were 50 producing placers in the county in 1918 and 12 productive deep mines, a total of 62. Placer County continues to be the leading drift-mining county of the State.

Of the output of the deep mines at Auburn that of the California Crandall Mining Co. was derived from specimens mortared. The 5-stamp mill of this company was rented for six months to the Ophir Consolidated mines. The Oro Fino Mining Co. has a mine which is opened by a 600-foot inclined shaft, and is equipped with a 10-stamp amalgamation and concentration mill. The plant was operated continuously during the year but with only one shift. Other deep-mine producers near Auburn were the Anderson, Bell, Garbe, and Stockholders Mining Co. At the Numitor mine, near Colfax, development work was done mainly in 1918. The mine is opened by a 500-foot drain tunnel and a 264-foot incline shaft. There is a 15-stamp amalgamation and concentration mill on the property. The Marigold Quartz, at Forest Hill, is a pocket mine. The Dairy Farm copper mine, near Lincoln, was the most productive deep mine in the county and, in addition to the copper, produced considerable gold and silver. The Rawhide, near Towle, is now owned by the Canyon Mines Corporation. The Pioneer Gold Mining Co. did very little work in 1918, its mine being virtually closed down. The mine is opened by two adits, 3,000 and 1,600 feet long, and about 3 miles of drifts. It has a 20-stamp amalgamation and concentration mill and a 2-ton cyanide plant for concentrates.

Among the placers the Pacific Gold Dredge Co. operated productively for six months of 1918 on North Fork of American River, 10 miles from Auburn. A number of small and Chinese mines were doing more or less placering in the vicinity of Auburn. At Blue Canyon the Aiken and Lost Camp placers operated. At Butcher Ranch the principal producer was the El Dorado & Placer Counties Gold Mining & Power Co., which operates a dredge at that point. The Christmas Hill is also a small placer producer there. In and near Dutch Flat are the Hadsel, Chin Mow, Ah Hee, Nichols, Holland, Michigan & Wisconsin, Wong On Wo, and several other productive small placers, and near Emigrant Gap there were some placers making small outputs. In and around Forest Hill the largest producer is the Reamer Mining Co. (Excelsior.) Others in the same vicinity are the Ah Jim, Baltimore Canyon (tailings), Delorsi, De Maria, Hadix, Mahoney, Mayflower, Paragon, Wah Hop, and a few smaller ones. The total gold output of the Forest Hill section in 1918 was $40,402. At Iowa Hill are the Gleason Consolidated Drift and Lowell mines. The principal placer near Last Chance is owned by the Red Star Mining Co. Other placers near Last Chance are the Dixie Queen, Glen, Kavanaugh, and Pacific Slab Consolidated mines. The productive placers at Michigan Bluff are the Big Gun, Dooley, Gorman Consolidated, Hard Climb, and a number of smaller placers worked in the creeks during the rainy season. There are a few small placers worked near Rocklin and Yankee Jim.

PLUMAS COUNTY.

The total yield in all metals from Plumas County in 1918 was $800,294 greater in value than in 1917, and in 1917 it was $799,196 greater than in 1916, which increase really shows the marked growth of the copper mining industry in the county. The quantity of ore treated in the county in 1918 was 112,920 tons larger than in 1917.

The production of gold from deep mines was $96,857; the silver amounted to 156,589 fine ounces, valued at $156,589; and the copper to 11,191,743 pounds, valued at $2,764,361. The increase in the copper was 3,720,651 pounds, valued at $724,753. There were 302,893 tons of ore treated, of which 9,067 tons were siliceous ore and 293,826 tons copper ore. The ore sent to gold and silver mills produced $58,122 in gold in the bullion and 362 ounces of silver, valued at $362, a total of $58,484. From the ore treated at concentrating plants there were derived 22,086 tons of concentrates, yielding $37,744 in gold and 149,568 ounces of silver, valued at $149,568, or an average per ton of $8.48 in gold and silver. The 1,484 tons of ore sent to smelters yielded $991 in gold and 6,659 ounces of silver, valued at $6,659, or a total of $7,650. The 11,191,743 pounds of copper was derived mainly from the flotation concentrates and to a less degree from crude copper ore shipped to smelters. Of the producing mines 27 were placers and 12 were deep. Of the placers 5 were hydraulic mines, 8 were drift, and 14 were surface placers. The hydraulic mines produced $18,402 in gold, the drift mines $4,589, and the surface placers $5,359, a total of $28,350 from placers. There was a decrease of $24,866 in the production of gold from all classes of placer mines in 1918.

Of the deep mines of the county only a nominal quantity of gold was produced by the Jackson group, at Crescent Mills. At Greenville the only deep producer was the Droege, which ran from June 15 to December 31 with periods of inactivity. The mine has a 25-stamp amalgamation and concentration mill. The Jamison Mining Co. owns the principal mine at Johnsville, which is opened by a vertical shaft 165 feet deep and an 1800-foot drain tunnel, with 5,532 feet of drifts, raises, and crosscuts. The mine has a 20-stamp amalgamation mill, but owing to shortage of labor only 10 stamps of the mill were kept dropping 188 days. The Walker Mining Co., at Portola, has one of the largest copper mines in the county and produces considerable gold and silver in addition to the copper. The mine is equipped with an 80-ton flotation process plant for concentration of the ores, the concentrates being sold to the International Smelting Co., of Tooele, Utah. The Seneca Consolidated Mining Co. (White Lily) made a considerable output of gold at Seneca and a small quantity came from the Gold Leaf, at Spring Garden. The Beetle and Beetle Extension mines (Trask Copper Mining Co.), at Taylorsville, were operated eight months in 1918, and a 15-ton concentration mill was put up during the year. The products were sent to the Garfield smelter for treatment. The Engels Copper Mining Co., at Taylorsville, was, in 1918, the largest copper-producing mine in California. With the exception of a few hundred tons of crude ore shipped to a smelter, all the copper produced was from flotation concentrates. The mine has two oil flotation concentration mills, with a total capacity of 1,100 tons a day, and the concentrates are shipped to the Garfield smelter, Utah. These concentrates averaged 27 per cent copper, with high values in gold and silver. Ball and tube mills are used for crushing the ore. Mine and plant were operated continuously throughout the year. The property is developed mainly through tunnels and drifts, but two vertical shafts are also being sunk. The Ruby and Fielding copper mines are also being worked productively at Taylorsville.

Twenty-seven placer mines were productive in Plumas County in 1918, of which 5 were hydraulic, 8 drift, and 14 surface placers. At Belden are the Ellis, Caribou, Indian Hill, and Pioneer drift mines and several small mines were worked at Blairsden. The Cadmus and Grant Divide are at Crescent Mills and the Red Ravine, Continental, and Standard Mining Co. are at Johnsville. The Plumas Grass Valley Mining Co., near La Porte, was drilling to find the main gravel channel but obtained a small quantity of gold from tailings from ancient river-bed mining. The St. Louis is a large producer near La Porte, and there are other smaller mines. The New York, Old Rutherford, and Little Annie are small placers at Meadow Valley, but water for washing gravel was scarce and only enough was available for a few weeks' washing. The Schley and a few other mines were operated at Quincy. The River Leasing Co., Seneca Development Co., Wiedener, and Yankee Bar (or Dean) made small outputs of gold at Seneca, as did the Spring Garden and Buckhorn, at Spring Garden, and the Twelvemile Creek mine, at Twain.

SACRAMENTO COUNTY.

Sacramento was fourth in rank among California gold-producing counties, and its total output of gold in 1918 was $1,694,724, or $224,857 less than in 1917. The total yield of gold and silver was $1,699,361, or $224,707 less than in 1917. Virtually the entire output of the county was produced by gold-dredging operations in the vicinity of Folsom. Ten dredges were at work in 1918, of which nine were owned by the Natomas Co. of California and one by the Indiana Gold Dredging Co. The dredge output of $1,690,279 in gold in the county was $223,225 less in 1918 than in 1917. Considerable platinum was obtained from the dredging operations of the Natomas Co. One drift mine operating near Folsom had a nominal yield and one deep pocket mine near Folsom produced a few thousand dollars in gold.

SAN BERNARDINO COUNTY.

The quantity of ore treated in San Bernardino County decreased in 1918, as compared with 1917, as well as the gold, silver, lead, copper, and zinc produced. The total decrease in 1918 in value of all metals produced was $369,855, as compared with 1917—gold decreased $125,751; silver decreased 19,212 fine ounces; copper, 221,397 pounds; lead, 1,563,861 pounds; and zinc, 43,392 pounds.

The output of gold was valued at $29,225 in 1918; the silver amounted to 88,712 fine ounces, valued at $88,712; copper, 1,350,728 pounds, valued at $333,630; lead, 631,930 pounds, valued at $44,867; and zinc, 2,824 pounds, valued at $257. Thirteen gold mines, 13 copper mines, 1 copper-lead mine, and 13 lead mines, a total of 40, reported production in this county in 1918. There was also one productive surface placer. There were 5,170 tons of siliceous ore sold or treated in 1918, 14,704 tons of copper ore, 1,264 tons of lead ore, and 270 tons of copper-lead ore. No distinctly zinc ores were mined, the zinc being derived from other ores.

The crude ore sent to smelters amounted to 16,277 tons, which yielded $5,909 in gold and 63,397 fine ounces of silver. In addition, 1,000 tons of old tailings were worked, which yielded $2,129 in gold and 313 ounces of silver. The copper ores produced 215.90 fine ounces of gold and 40,313 fine ounces of silver; the lead ores 63.95 fine ounces of gold and 12,528 fine ounces of silver, and the copper-lead ores yielded 4.02 ounces of gold and 7,759 ounces of silver.

The Bagdad-Chase Gold Mining Co., at Barstow, made only a small output and no improvements were made in 1918. The mine has a 50-ton cyanide plant. The Copper Buttes was another small producer at this point. The Copper World mine, of the Ivanpah Copper Co., at Cima, was the most productive mine in the county, the values being mainly in copper with some silver and a little gold. The matte produced at the company's smelter was shipped to Garfield, Utah, for refining. The Mohawk lead mine, of the same company, at Cima, yielded lead with some copper and silver. Other producers at Cima were the Frances Copper Co., Flee copper mine, Jost copper mine, Express copper mine, Fayle lead mine, and Standard copper mine. The producers at Daggett were the Cheatham silver mine, Calico lead mine, Daggett silver mine, Oriental & Red Cloud silver mine, Waterloo Mining Co. (Red Jacket and Silver King) silver mine. At Fenner the Bonanza King silver mine was worked only about two months. This property has a 10-stamp concentrating mill and a cyanide plant. The Emerson and Providence mines were operated in a small way, and quite an output of copper came from the Von Trigger mine at the same place. At Hallock the producers were the Mansfield, Tanzer, and Davis & Maxfield properties. The Perseverance Mining Co. made a nominal output at Goffs, and there was some yield from the Carbonate King lead-zinc mine. Small outputs were made by the Cooke & Dudley and Lampi properties, at Needles, and also from the Emperor (Ivanpah Copper Co.), at Nipton. C. A. Roberts shipped a small quantity of lead ore from Silver Lake, and the Riggs silver mine shipped silver ore from the same place. The Pacific Mines Corporation (Bagdad-Chase and Roosevelt mines), at Stagg, made considerable shipments of gold ore. The Eagle Sulphide Co., at Vidal, shipped copper ore. The Alvord, at Yerma, has a 6-stamp amalgamation mill and made a small output of gold. The only placer mine in the county is the Coolgardie Mining Co., 20 miles north of Barstow, which is not worked commercially, but a small quantity of gold was taken out by caretakers.

SHASTA COUNTY.

The total value of the output of metals in Shasta County in 1918 was $7,462,642, which was $1,755,754 less than in 1917. The main decrease was in zinc and copper, although there was an output of lead in 1918 and none in 1917. There was a decrease in gold from deep mines as well as from placers. The number of producing mines in the county was 38, or 15 more than in 1917. The output of gold was valued at $543,509, a decrease in 1918 of $231,616, as compared with 1917. The yield of silver in 1918 was 420,410 fine ounces, valued at $420,410, a decrease of 211,511 ounces. The output of copper in the county in 1918 was 25,029,899 pounds, valued at $6,182,385, a decrease of 1,628,980 pounds in quantity and of $1,095,489 in value, as compared with 1917. The recoverable zinc was 3,045,692 pounds, valued at $277,158, a decrease of 3,274,837 pounds in quantity and of $367,536 in value, as compared with 1917. There was no lead production in 1917, but in 1918 there were 551,830 pounds, valued at $39,180. Shasta, notwithstanding its serious decrease in value for the year 1918, continues to be the leading county in the State in total value of metallic output. It also leads all other counties in the values of copper and zinc, but for the second time in many years its silver output has been exceeded by that of Inyo County.

The total number of deep mines from which production was reported in Shasta County in 1918 was 25, as against 17 in 1917. Of these 11 were gold mines, 2 were silver, 11 were copper, and 1 was zinc. The output of 459,780 tons of ore was made up of 24,486 tons of siliceous ore (the silver ore is included in the siliceous ore), 420,298 tons of copper ore, and 14,996 tons of zinc ore. The placer mines of the county in 1918 yielded 11,784 fine ounces of gold, valued at $243,597. This production came from 4 dredges and 9 surface placers.

The gold from deep mines amounted to 14,508.24 ounces, valued at $299,912, and the silver to 418,621 fine ounces, valued at $418,621.

The gold derived from siliceous ore amounted to 4,811.62 fine ounces, valued at $99,465, and that from copper ores to 9,676.35 fine ounces, valued at $200,028; from zinc ores were derived 20.27 fine ounces, valued at $419. The production of silver from siliceous ore was 9,736 ounces, from copper ores 370,493 ounces, and from zinc ores 38,392 ounces. The siliceous ore, therefore, yielded $109,201 in gold and silver, the copper ore $570,521 in gold and silver, and the zinc ore $38,811 in gold and silver.

The gold and silver mills in Shasta County in 1918 treated 2,920 tons of ore, which yielded in gold bullion $41,439 and 1,409 fine ounces of silver, valued at $1,409. This was an average of $14.67 a ton in gold and silver. All classes of ore shipped to concentration mills amounted to 132,428 tons of ore, from which 18,107 tons of concentrates were derived, yielding (aside from copper content) $4,357 in gold and 41,217 ounces of silver, valued at $41,217, a total value from the concentrates in gold and silver of $45,574. The average value per ton of concentrates was $0.24 in gold and $2.27 in silver, in addition to the value of the copper content.

The crude ore sent to smelters, amounting to 324,415 tons, yielded (in addition to copper) $254,116 in gold, an average of $0.78 a ton, and 375,979 ounces of silver, valued at $375,979, or $1.16 a ton. The total value of gold and silver recovered from ore sent to smelters was $630,095, or an average value of $1.94 a ton as against an average of $2.50 in 1917.

A small quantity of copper ore was shipped from the Tarfar property at Bella Vista. The Balaklala Consolidated Copper Co., at Coram, was operated the entire year with no material changes. This property is developed by adits of a total length of 20,000 feet, 12,000 feet of diamond drilling, and 2,000 feet of tunnels. The sulphide ores produced were all shipped to the Mammoth smelter, at Kennett, for reduction. All ore from the Shasta King copper mine, at Coram, was treated at the Mammoth smelter. The Shasta Hills Mining Co., at French Gulch, is equipped with a 5-stamp mill and Senn concentrator. The mine closed down in September, 1918. The only work done at the property of the Western Exploitation Co. was that of a few lessees, and a little gold was obtained by other small operators in the vicinity. The Big Dyke and White Star mines were worked in a small way at Igo. The Afterthought Copper Co., at Ingot, was the largest producer of zinc in Shasta County and the ore yielded also considerable copper and silver and a little gold. Part of the concentrates were sold at a flat rate per ton, based on the content of zinc, but the zinc in the copper concentrates was penalized. The Mammoth Copper Co., at Kennett, the most productive property in Shasta County, was operated the entire year but on a restricted scale because of labor conditions. This company has a 5-furnace smelter, with 3 furnaces and 2 converters operating in 1918. The treatment is pyritic smelting producing blister copper. The refining is done at Chrome, N. J. This company does a large amount of custom work for mines in Shasta and other counties, as well as from other Pacific Coast States. The output of the Mammoth mines themselves consisted of copper, lead, zinc, silver, and gold. The company was the largest producer of lead in the county and the largest producer of silver in the State. Some copper came from the Stowell mine, at

Kennett, and a little gold from the Exchange mine at the same place. The Mountain Copper Co. (Ltd.), at Keswick, was the largest producer of copper in Shasta County in 1918. The three mines worked by this company are in one group, contiguous to one another, and are the Iron Mountain, No. 8, and Hornet. There is a concentration mill at Minnesota, 5 miles from the mines, with a capacity of 500 tons per day. Crude ores and the concentrates from this mill are transported to the company's smelting plant at Martinez, on San Francisco Bay (about 250 miles). The mines, mill, and smelter were in operation during the whole of 1918. The sulphide ore is roasted to manufacture sulphuric acid and then the calcines, with suitable mixture of other ores, are smelted in reverberatories. The copper matte carrying the gold and silver is converted into blister and shipped to the Baltimore Smelting & Rolling Co., Baltimore, Md. Developments in No. 8 mine have been uniformly successful, resulting in an increase of reserves and average grade. A new plant to treat old mine filling was completed at the end of the year. At the smelter, at Martinez, because of abnormal conditions costs rose to a point somewhat above those of the period that preceded the change in mining and smelting methods. The leaching plant worked well and is to be enlarged to treat a larger quantity of calcined material from the Hornet mine. Small outputs were made by the Pittsburg & Mount Shasta Mining Co., at Keswick; and the Yankee John and other small deep mines, at Redding. The Art Brown and a few other mines made nominal productions at Schilling. Considerable gold was obtained from the Evening Star mine, at Whitehouse, the ore being used as a flux at the Mammoth smelter. The Bully Hill mine, at Winthrop, is opened by a vertical shaft 600 feet deep and some 10,000 feet of drifts. During 1918 the Rising Star shaft was unwatered 400 feet, the mine workings were reopened, and new development was accomplished. The mine is equipped with a 300-ton smelter and a railroad 17 miles long to Pitt. A 100-ton flotation plant was added in 1918. The copper ore was treated at the Mammoth smelter and the zinc in the ore was penalized. Experiments are being made for the recovery of zinc. Some copper ore was shipped to the Mammoth smelter from the Baxter mines, at Ydalpom.

A few small placers were worked productively at French Gulch. The Shasta Dredge Co. worked stream gravel at Cottonwood. The dredge has 5-cubic-foot buckets and is operating on Cottonwood Creek, 2 miles east of Gas Point. The Big Boulder and Grubstake placers were worked at Lamoine. The American Gold Dredging Co. started a new dredge on the Sacramento River, near Redding, on November 15, 1918. On Clear Creek, near Redding, Lawrence Gardella operated 2 gold dredges in 1918. Some small placers were worked productively near Redding, Schilling, and Taylor.

SIERRA COUNTY.

The total production of metals in Sierra County in 1918 was valued at $291,489, as compared with $386,057 in 1917, a decrease of $94,568. The deep-mine gold decreased $62,520 and the placer gold $32,540. There were 24,833 tons of siliceous ore treated in gold and silver mills in 1918, yielding $237,394 in gold and 1,882 ounces of silver, valued at $1,882, a total of $239,276 in gold and silver. This ore also produced 299 tons of concentrates, which yielded $23,371 in gold and 70 ounces of silver. No ores were sent to smelters nor were any tailings worked in 1918. The output of the placers of the county in 1918 was 1,383.67 fine ounces of gold, valued at $28,603, and 169 ounces of silver, valued at $169, a total of $28,772. Of the placer gold $13,037 came from hydraulic mines, $11,682 from drift mines, and $3,884 from surface placers. There were 34 productive mines in the county in 1918, of which 14 were deep gold mines. Of the placers, 4 were hydraulic, 11 drift, and 5 surface placers.

The Croesus Gold Mining Co. is an important deep-mine producer at Alleghany. The Mariposa Mine Association, which operated the entire year, has a 5-stamp amalgamation mill. The Original 16 to 1 Mine (Inc.) is opened by a tunnel 1,200 feet long. At a point 800 feet from the mouth is an incline winze (equipped with an electrical hoist) of about 700 feet on the dip of the vein, or 400 feet vertical. Seven levels have been opened from this winze. The equipment consisted of a Chipmunk crusher and a Berdan pan, but a 10-stamp mill has been installed since the end of the year. Tailings from this mine have been considered as concentrates and shipped to a smelter for treatment, as the crude ore is of exceptionally high grade. The Tightner Mines Co. closed down its mine in October, 1918. The property has a 20-stamp amalgamation and concentration mill, but the concentrates were stored, as there are no facilities for treatment. The Giebel, Harris, Snow Drift, and other small mines made some production of gold. At Downieville the Cliff Leasing Co. and Mohawk mine were small producers. The Four Hills mine, at Johnsville, was worked under lease. There is a 20-stamp amalgamation mill on the property. The only producers reporting from Sierra City were the Cleveland & Monarch, Swastika, and Primrose mines. The old 10-stamp mill at the Primrose mine was rebuilt in 1918 from old machinery on the ground, but only 5 stamps were put into operation and worked intermittently in the summer and fall.

A little drift mining is carried on near Alleghany and at Brandy City, where the only mine of importance is that of the Brandy City Mining Co., which is hydraulicking bench gravel between Canyon and Cherokee creeks. At Downieville the placers which produced were the Big Boulder, Grizzly Ridge, Monte Carlo, Wide Awake, and Taylor mines. The Kirkpatrick drift mine, 2 miles from Goodyears Bar and tailing into Woodruff Creek, is working an old river channel. The Poor Boy drift did little more than development work. The St. Charles Hill drift mine spent about eight months of the year in driving tunnels, without breasting. The Motor Mining Co., Confidence Mining Co., at Pike, and some placers at Scales and Table Rock made small outputs only. The active placers at Sierra City were the Fisher, Last Resort, Pride Mining Co., and Washington.

SISKIYOU COUNTY.

In 1918 Siskiyou County produced 14,233.23 fine ounces of gold, valued at $294,227; 14,501 ounces of silver, valued at $14,501; and 573,435 pounds of copper, valued at $141,638, a total of $450,366.

This was a decrease of $192,096, as compared with 1917. There were 15 deep mines, as compared with 7 in 1917. They produced 5,306 tons of ore, yielding gold valued at $48,385, and 12,741 ounces of silver, valued at $12,741, a total of $61,126, as compared with $38,173 in 1917. The 54 producing placer mines yielded gold valued at $245,842, and 1,760 ounces of silver, valued at $1,760 in 1918, a total of $247,602, as compared with $304,260 in 1917. Thus it is seen that the placers yielded $186,476 more in gold and silver than the deep mines of the county. The number of producing mines (69) in Siskiyou County was larger than in any other county of the State. Of the placers 44 hydraulic mines produced $60,488 in gold; the three dredges, $181,882; and the seven surface placers, $3,472. The hydraulic mines produced $41,432 less and the dredges $973 less gold in 1918 than in 1917.

Of the deep mines a small quantity of gold was taken from the O'Shea pocket mine, at Cecilville. The Homestake, at Etna Mills, has a 5-ton amalgamation mill. The Dewey Mines Co., at Gazelle, only worked in March and April owing to abnormal mining conditions. The mine has a 10-stamp mill, electrically driven. The Hazel mine, at Hornbrook, operated to June 4 and then closed down. There is a 10-stamp amalgamation and concentration mill on this property. The Indian Girl mine, at the same place, made a small gold output. The Blue Ledge Mines (Mexican Mining & Smelting Co.), at Copper, was the most productive deep mine in the county, its main output being in copper. The ores are sold to the smelter at Tacoma, Wash., being sent from Jacksonville, Oreg., by rail. The main adit in these mines is 1,400 feet long and there are about 750 feet of drifts and raises. The only change at the mines in 1918 was the displacement of hand drills by air drills. The producers at Rollin were the Eureka & W. Y. O. D., Ida May & Elizabeth Sanger, and Snowflake & Little Gem mines. A nominal output was made with the 3-stamp mill of the Oregonian mine at Sawyers Bar. At Yreka the deep producers were the Easter and Gypsy mines. The Gypsy has a Gibson mill; the mine closed down in May, owing to high cost of operation.

Among the placers a few small ones near Black Bear made some production. Among the hydraulic mines at Cecilville, the Jefferson Consolidated Mining Co., like others, had a short water season. The Last Chance hydraulic mine, of the Hidden Channel Mining Co., worked only long enough to place the monitors for the 1919 season, though some output was made. Other hydraulic mines operating were the Banner, Farrington, Summerville (South Fork), and O'Shea. The Daisy Bell is a small mine at Dunsmuir and the Bennett & Co. and Walheim hydraulicked at Forks of Salmon. The Siskiyou Dredging Co. operated its dredge 12 months on McAdams Creek, near Fort Jones, and some small placers were worked at the same place. From Gottville the only producer reporting was the Sulphur Springs hydraulic mine. The Hawkeye and some smaller hydraulic mines produced gold at Greenview. The principal producers at Hamburg were the Dick Morris, Jahde, and Kunz Flat hydraulic mines. The principal producers at Happy Camp were the Davis Consolidated Mines and South Fork; smaller hydraulic mines making an output were the Crompton, Bing, Nolan Bar, Shady Run, and Siskiyou Mines Co. (Morgan Point.) There were only a few small placers worked at Hornbrook and Oak Bar. At Sawyers Bar the most productive mine was the Forks of Salmon River Mining Co., which worked stream and bench gravels by hydraulicking and elevating on the North Fork of Salmon River, 10 to 14 miles from Sawyers Bar. Another productive hydraulic mine was the Wm. Burns Point, working on Eddys Gulch, which was worked for 85 days. Still other productive hydraulic mines at Sawyers Bar were the Gold Bank (working eight months), Gold Hill, Paddy Cronin, Kun Wo Chung, Meyer, and Old Hump Back. At Scott Bar the Quartz Hill and Roxbury hydraulic mines had a very short water season. The productive hydraulic mines at Seiad Valley were the Great Northern and Lowden; those at Somes Bar were the Blue Nose and Ten Eyck; and those at Walker were the Barkhouse Creek and Crary. The Klamath River Dredging Co., at Oak Bar, did dredging work most of the year but went out of business November 15,1918, and the dredge was dismantled. The principal producer at Yreka was the El Oro Dredge Co., which operated the whole year on Greenhorn Creek. There was a considerable output of gold from a number of small placer mines in that vicinity in 1918.

TRINITY COUNTY.

In 1918 Trinity County produced 21,513.76 fine ounces of gold, valued at $444,729, and 6,912 ounces of silver, valued at $6,912. The total value of all metals, including copper, was $642,972, a decrease of $325,335 from 1917. The decrease of gold was $157,319. Thirty-eight mines reported production in 1918, or 9 more than 1917. Of these 6 were deep gold mines and 1 was copper; and of the placers 21 were hydraulic, 4 dredges, 1 drift, and 5 surface placers. The deep mines produced from 5,677 tons of ore 842.98 fine ounces of gold, valued at $17,426, and 5,142 ounces of silver, valued at $5,142, a total of $22,568 in gold and silver, as compared with $28,949 in 1917, a decrease of $6,381. The ore treated was less by 3,124 tons than in 1917. The 31 placers yielded 20,670.78 fine ounces of gold, valued at $427,303, and 1,770 ounces of silver, valued at $1,770, a total of $429,073 and a decrease of $154,047 in 1918, as compared with 1917.

Among the deep mines, the Index Gold Mining Co., at Burnt Ranch, had a 6-stamp mill, with concentrator. This was dismantled by a company having the mine under bond, and a patent crusher and a 6-ton cyanide plant were installed. Only a small output was made by the Brown Bear Mining Co., at Deadwood, and by the Dixie Queen, at Douglas City. The most productive deep mine in the county is that of the Island Copper Co., at Island Mountain, which was operated 362 days. The copper ore is a heavy sulphide and was all shipped to the smelter at Tacoma, Wash. The ore body is near the surface and is opened by many adits. The Blue Jay & Knob Rocket mine, at Lewiston, is worked through tunnels and has a 5-foot Hardings mill. The Five Pines & Surprise property, at Trinity Center, made a small output only.

The placer mines of Trinity County are numerous and are mainly hydraulic, but 4 dredges were operated in 1918. At Big Bar, the Fortune Teller and several Chinese and small hydraulic mines were productive in 1918. The McAtee Bar is a small hydraulic mine, at

Burnt Ranch. The Pacific Gold Dredging Co. operated for six months on river gravel in the Trinity River, near Carrville, and there were some smaller placer operations in the same vicinity. At Coffee the hydraulic mines were the Schlomberg, Underground Treasure, and Steves Gulch. At both Denny and Douglas City several small placers were producers. At Hayfork the principal hydraulic producing mines were the Canebo, Leach, and Murphy & Layman, and a small output was made by the Rattlesnake hydraulic mine at Helena. Most of the hydraulic miners of the county complain of a very dry season and the resultant shortness of water for washing gravel. The principal placer at Junction City is the Valdor Dredge Co., which operated the whole year. Productive hydraulic mines at this place were the Berger & Heimberger, Chapman & Fisher, Bailey, and Last Chance. At Lewiston the largest production of gold was made by the Trinity Dredge Co. Other producers there were the Bablew Mines Co. (hydraulic), Donnelly Gulch Mining Co. (drift), and Jennings Gulch Mining Co. (hydraulic) mines. The Estabrook Gold Dredging Co. operated for three and a half months on stream gravel in Trinity River, at Trinity Center. At Weaverville the largest producer was the La Grange Mining Co., which hydraulicked ancient river-bed gravel on Oregon Mountain, at the head of Oregon Gulch. Productive hydraulic mines at Weaverville were the Horseshoe, Louis Wah Ton, and Poverty Flat.

TUOLUMNE COUNTY.

The output of gold in Tuolumne County in 1918 was 13,270.61 fine ounces, valued at $274,328; of silver 21,425 fine ounces, valued at $21,425, a total value for the year of $295,753, a decrease of $33,140, as compared with 1917. The deep mines of the county produced 44,529 tons of ore, which yielded 13,199.60 fine ounces of gold, valued at $272,860, and 21,417 ounces of silver, valued at $21,417, a total value of $294,277. No production of copper was reported in 1918, although 12,000 pounds were reported in 1917. There were 43 producing mines in the county in 1918, of which 2 were placers and 41 were deep mines. This makes 25 more mines reporting production in the county in 1918 than in 1917, but most of the new mines were small operations.

The total quantity of ore sold or treated in the county in 1918 amounted to 44,529 tons, or 3,002 tons more than in 1917. There were treated 15,060 tons of ore in gold and silver mills, yielding $136,955 gold bullion and 2,118 ounces of silver, valued at $2,118, a total in mill bullion of $139,073, or an average of $9.23 a ton in gold and silver. From the milling ore 3,290 tons of concentrates were obtained which yielded $135,203 in gold and 19,221 ounces of silver, valued at $19,221, a total of $154,424 in gold and silver, and a total average yield per ton of $46.94.

The ore milled and concentrated yielded a total value of $272,158 and $21,339 in silver. The total yield of gold and silver on the plates and from the concentrates was valued at $293,497.

There were 133 tons of old tailings worked, which yielded a small quantity of gold and silver.

Of the deep mines of the county a small output of gold was made by the Grizzly pocket mine and the Mohrman mine, at Big Oak Flat; and a little gold came from the Menke and other small quartz mines, at Chinese, as well as from the Blue Eagle (Eleanor Mining Co.), at Buck Meadows. At Columbia a little gold was obtained by hand-mortaring from the Broad Axe pocket mine. Some gold also came from the Experimental Gulch, the Fox & Hudson, and the Over pocket mines. The Volunteer was worked in a small way, an old Kincaid 3-stamp mill being used. There was no regular operation of the mill or mine of the Confidence Gold Mines Corp., but a short test run was made pending development of the mine. From Groveland small shipments of gold were made by H. W. Hilliard and T. R. Reid. The producers in a small way at Jamestown were the McCormick Co., Josephine, Rawhide, Magenta, Homestead, Guthrie, and Santa Ysabel mines. The most productive mine in the county in 1918 was the Belmont Shawmut Mining Co., at Shawmut, in which development work was continued for twelve months and productve operations for five months of 1918. Operations were discontinued in November on account of conditions of labor and war, but were resumed after the end of the year. The total development work in this mine, including incline shafts, adits, drifts, and crosscuts, amounts to 49,650 feet, of which 2,736 feet were cut in 1918. The process of treating the ore is by gravity concentration and flotation. The equipment includes 70 stamps, a 500-ton concentrator, 10 Butchard tables, 2 Dorr classifiers, 1 tube mill, 9 Jones-Belmont flotation cells, 3 vacuum collecting tanks. There is a Blaisdell excavator and aerial tramway to the concentrate bin, which were remodeled in 1918. A large quantity of tailings has been impounded. At Sonora the Fortuna mine was operated in 1918 after February. The developments consist of an incline shaft 127 feet deep, a 300-foot tunnel, and a drift of 90 feet, all completed during the year. The equipment consists of a 50-ton Hendy ball mill, a Senn amalgamator, and two Union concentrating tables. Other producers at Sonora were the McArdle, Kapor, Sugarman, and Ridgway properties. The Black Oak Mines & Milling Co., at Soulsbyville, was in operation only from January to August 5. The mine is opened by a 1,700-foot incline shaft. There is an all slime cyanide plant of 75 tons capacity at the mine. The Jumper-California Mining Co., at Stent, is opened by a 1,450-foot incline shaft, a 400-foot winze, and several miles of drifts and crosscuts. The equipment consists of a 20-stamp amalgamation mill. The mine was operated under the leasing system continuously in 1918, but later closed for an indefinite shutdown. Other mines productive in a small way, at Stent, were the Bogan, Mazeppa, and Nyman Consolidated. The deep-mine producers at Tuolumne were the Star King and Taylor. Those at Tuttletown were the Tappie, Mulock, Gillis, and Norwegian Consolidated pocket mine, the last being the largest producer. The only productive placers in the county were the Turner Flat, at Jamestown, and the Morrice, at Sonora.

YUBA COUNTY.

In 1918 Yuba was the leading county of California in the production of gold, exceeding the yield of both Amador and Nevada counties. Thus it appears that a placer-mining county of the State may produce more gold than any of the quartz-mining counties. This superiority was due in 1918 entirely to dredging operations.

The output of the county in 1918 was $3,767,933 in gold and 13,796 ounces of silver, valued at $13,796, a total of $3,781,729 in gold and silver, an increase of $97,465, as compared with 1917. The dredges in 1918 produced $3,750,033 in gold, which was $90,822 more than in 1917. Twelve dredges were in operation in the county in 1917, and, besides these dredges, there were 1 drift, 8 surface placer, 1 deep gold, and 1 copper mine, a total of 23 mines producing in 1918.

The most extensive gold-dredging enterprise in California, and indeed in the United States, is that of the Yuba Consolidated Goldfields, on Yuba River, near Hammonton, in this county. This company had 8 gold dredges of the largest size in operation for the full twelve months of 1918. In addition to the gold 115 ounces of platinum was recovered from the stream gravel worked. The Yukon Gold Co. also had 1 dredge working in Yuba River for ten and a half months of 1918. The Marysville Dredging Co. operated continuously 3 dredges at Marigold on the old gravel plain deposited by Yuba River. Considerable gold was obtained from small placer and Chinese mines in the vicinity of Camptonville and some came from the Mix, Pepper, and other placers at Dobbins. The Archimedes worked old tailings at Marysville for one month only. The Blue Point drift mine, at Smartsville, operated about one-third of the year on cemented gravel, which is crushed in a Dodge mill and then run directly into sluices. There were some small productive placers at Marysville, Smartsville, and Woodleaf. The only deep mines producing in the county were the Burris gold mine, at Browns Valley, and the Paul copper mine, near Marysville.

OTHER COUNTIES.

Fresno and San Luis Obispo counties.—The sluicing placers in Fresno County were the Wilkinson, at Laton; Grant Rock & Gravel Co., at Friant; and Mitchell, at Sanger. No deep mines in this county reported production in 1918. The entire output of the county was $4,832, of which $4,795 was gold and the remainder silver. In San Luis Obispo County the Goodwill Mining Co., at San Luis Obispo, shipped copper ore to both the Tacoma and the Mammoth smelters. The mine is equipped with a 100-ton capacity ball mill and 2 concentrators and a flotation plant, constructed in 1918. The mill was only operated three months in 1918.

Merced, Stanislaus, and San Joaquin counties.—In each of these counties one gold dredge was operated, as well as a few small placers. The dredge in Merced County was that of the Yosemite Dredge & Mining Co., that in Stanislaus County belonged to the La Grange Dredging Co., and the one in San Joaquin County was that of the American Gold Dredging Co. The total output of all placers in these counties, including the dredges, was $226,008 in gold.

Contra Costa and Marin counties.—In Contra Costa County the Mount Diablo Copper Co. shipped some copper ore. In Marin County copper ore was shipped by the Chetco Copper Mining Co. early in the year, and the mine was then closed down.

Imperial and Riverside counties.—The Crane and the Red Cloud Consolidated Mining Co. were the only producers reporting from Imperial County. The two mines reporting output in Riverside County were the Happy Day, at Vidal, and the McLeish, at Blythe.

Modoc County.—The only deep gold mine which reported production from this county was the Hess Gold Mines Co., at Adin.

GOLD, SILVER, COPPER, AND LEAD IN OREGON.

(MINES REPORT.)

By Charles G. Yale.

INTRODUCTION.

The total metal output of Oregon declined in value 12.64 per cent in 1918, as compared with 1917. Most of the decrease was due to the smaller output of gold from the dredging industry, although the lower selling price of copper was also a factor. So far as gold derived from deep mining was concerned, the output in 1918 was slightly larger than that in 1917.

Oregon was to some extent affected by the war conditions, but very much less so than the other Western States. The rather serious decrease in value shown in the total output of metals, as stated above, is easily traced to the much lessened yield from dredging operations and, to a small degree, to the lower prices for copper. The fact that the deep mines produced slightly more gold in 1918 than in 1917 shows that war prices scarcely affected them. It is a noteworthy fact that the number of mines in Oregon reporting production in 1918 increased by 44, or nearly 58 per cent more than in 1917. These added mines were mainly small properties, both placer and deep, where work was done by individuals, either old miners or others lacking regular employment. These men temporarily occupied themselves in creeks, gulches, and ravines, or worked over old dumps and sulphuret piles, sending small shipments to mints, smelters, and assay offices.

One notable feature in the reduction of the ores of the State is shown by the fact that the recovery of gold by amalgamation fell off $112,301 in 1918, as compared with 1917, while the recovery by cyanidation increased $42,245 and by smelting $56,041. Several companies owning mills shipped ores to the smelters in preference to operating the mills, owing to high costs of labor and supplies. This accounts for the increase of gold recovered at smelters and the decrease in the recovery by amalgamation.

There were 25 more placers worked in the State in 1918 than in 1917, and 19 more deep mines. Of the deep mines, 31 were gold, 1 silver, 9 copper, and 1 lead. Aside from the output of the 3 dredges, the bulk of the yield of placer gold came from 50 active hydraulic mines, a little less than $25,000 coming from the combined drift and surface placers. The reduction in the yield of gold from the dredges was due to the fact that the principal companies have been working in ground containing less gold per cubic yard than the ground worked in 1917.

No large mining enterprises were begun in Oregon in 1918, notwithstanding the increase in the number of productive mines. And in fact there are few large mining operations carried on in the State. The deep mines having an annual production of more than $100,000 are those of the Baker Mines Co., Cornucopia Mines Co., Homestead Iron Dyke Co., and Commercial Mining Co., all in Baker County, and the Queen of Bronze Mining Co., in Josephine County. The only placer having an output valued at more than $100,000 is the Powder River Dredge Co., Baker County. It may be noted that these six properties produced 80 per cent of the total value in 1918, and that one of them produced 25 per cent of the total.

The gold from deep mines, which amounted to $772,216 in 1918, increased $7,784 in 1918 as compared with 1917. Whereas lack of labor, higher wages, and increase in cost of supplies and power caused a reduction of 15,757 short tons in the quantity of ore treated, yet this ore averaged $6.91 a ton in gold and silver in 1918, as compared with $6.05 a ton in 1917, an increase of 86 cents, or 14.21 per cent, in 1918. This increase in value per ton more than offset the smaller quantity of ore mined and treated during the year. Included in these figures of the deep mines is the gold derived from copper ores, which amounted to $86,803, or $36,674 more than in 1917.

The only decrease in production of gold in Oregon in 1918 by impoverishment or depletion of the deposits worked can be traced directly to the dredging industry. The dredges produced $387,740 or $231,182 less than in 1917. This decrease was equal to about 46 per cent of the total production of gold from placers or 18 per cent of the total production of gold of $1,270,465. The depletion occurred in the older two of the three dredging deposits, the other and newer one increasing its output materially.

The hydraulic and drift mines combined showed a deficit of only $14,687, or about 3 per cent of the total placer gold valued at $498,249, or a little more than 1 per cent of the total gold, $1,270,465, and this decrease was due to short water seasons only.

The surface placers or sluicing mines showed an increase of $16,752 in gold output, or 3.36 per cent of total placer gold, or 1.32 per cent of total gold from all mines. The larger output from this source was due to the increased number of small mines worked in 1918 by "snipers," pocket hunters, prospectors, and old miners.

The southwestern counties of Oregon,[1] which contain an extension of the California gold belt, are Benton, Coos, Curry, Douglas, Jackson, Josephine, and Lane. These counties (with the exception of Benton and Coos, which reported no production) reported in 1918 a combined production of $128,371 in gold and $1,340 in silver, a total of $129,711. The production of placer gold in this region in 1918 was $84,618, a decrease of $5,399, and the production of gold from deep mines was $43,753, an increase of $16,695. The total increase in output of gold in these southwestern counties in 1918, as compared with 1917, was therefore $11,296. In Curry County a small increase in gold was shown, but several mines operated in previous years did not report production in 1918. The entire output of Douglas County in 1918 was small and there was a decrease of more than $18,000 in the output of gold, all of which was due to the lessened yield from the placer mines. Quite a material increase in total output was shown in Jackson County in 1918, which was all due to the increase from the deep mines, the placers showing a decrease.

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[1] Diller, J. S., Mineral resources of southwestern Oregon: U. S. Geol. Survey Bull. 546, pp. 9–127, 1914; Diller, J. S., and Kay, G. F., Mines of the Riddles quadrangle, Oreg.: U. S. Geol. Survey Bull. 340, pp. 134–152, 1908.

The Gold Ridge and Pearl deep mines added materially to their product, as compared with 1917, especially the Gold Ridge, the principal producer. The Gold Hill Mines Association which showed a good output of gold in 1918 did not appear among the producers in 1917. There was very little difference in the total output of gold in Josephine County in 1918 and 1917, but the quantity of copper produced was materially less in quantity in 1918, and the value decreased $100,000, so that the total value of the metallic output of the county was about $100,000 smaller than in 1917. The hydraulic mines of the county increased their product of gold for the year, but this gain was about balanced by the decreased quantity of gold from deep mines. There was only a small output of metals from Lane County in 1918 and even that was less than the year before.

Northeastern Oregon comprises the counties of Baker, Crook, Grant, Harney, Malheur, Umatilla, Union, Wallowa, and Wheeler. In 1918 no metallic output was reported from Harney or Union counties. The combined gold output of the seven producing counties in this region in 1918 was $1,140,709, of which Baker produced $1,009,656, or 88.5 per cent. There was a decrease of gold in 1918 in these counties, as compared with 1917, of $234,014, or 17 per cent. The yield of placer gold in 1918 was $413,631, a decrease of $223,718, or 35 per cent. The lode mines produced $727,078 in gold in 1918, a decrease of only $10,296, or 1.40 per cent. There was a decrease from this source of 25 per cent in 1917, as compared with 1916. The greatest decrease in gold in any county was in Baker—$218,543. Crook County showed an increase of $18,097, and Jackson, of $31,680; Grant County showed a decrease of $35,739, and Douglas, $18,180. In Baker County the important deep mines in Cornucopia and Cracker Creek districts showed some material increase in gold, but in the Mormon Basin district there was a decrease in gold which more than offset this gain. However, in Iron Dyke district there was an increase of about $52,000 in gold and of $21,000 in copper values. The principal mine in this district increased its total output in value of metals materially. There was a decided decrease in gold from placers in the Powder River district. The decrease of $18,180 in gold output in Douglas County in 1918, as compared with 1917, was due entirely to the yield of deep mines. The yield of gold in Malheur, Umatilla, Wallowa, and Wheeler was only nominal for each county and what little there was came entirely from placers.

The copper produced in Oregon in 1918 decreased less than 1 per cent in quantity, as compared with 1917, but the value decreased $70,134, or 10.38 per cent, the result of lower market prices for copper.

PRODUCTION.

GENERAL STATEMENT.

Gold, silver, copper, and lead produced in Oregon, 1907–1918.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine oz.*	*Pounds.*	*Pounds.*	
1907	206	110,698	$1,129,261	86,718	554,104	....	$1,297,316
1908	239	50,684	865,076	43,602	291,377	2,138	926,737
1909	162	59,281	781,964	27,827	235,000	400	827,001
1910	180	82 132	679,488	35,978	13,861	....	700,676
1911	176	98,558	633,407	45,221	93,136	....	669,016
1912	210	90,945	770,041	57,081	260,429	39,317	849,886
1913	173	155,901	1,627,710	179,036	43,330	87,207	1,746,402
1914	105	124,331	1,591,461	142,552	39,248	16,436	1,676,153
1915	95	155,791	1,861,796	117,947	451,172	62,957	2,003,509
1916	108	159,071	1,902,179	231,342	3,581,886	28,000	2,937,478
1917	76	142,438	1,491,798	125,656	2,474,487	....	2,270,874
1918	120	126,681	1,270,465	107,323	2,451,016	10,601	1,983,942
Increase or decrease, 1918	+44	−15,757	−221,333	−18,333	−23,471	+10,601	−286,932

The total metal output of Oregon decreased in value $286,932 in 1918, as compared with 1917. The quantity of ore treated decreased 11 per cent; the gold decreased 14.8 per cent in value; the silver decreased 14.6 per cent in quantity; and the copper decreased 0.9 per cent in quantity.

The mine production of Oregon, having a total value of $1,983,942 in 1918, was derived from 120 producing mines, of which 78 were placers of various kinds (including three dredges) and 42 were deep mines. The producing placers which reported increased in number by 25 in 1918, and the producing deep mines by 19. The total quantity of ore sold or treated was 126,681 short tons, a decrease of 15,757 tons. The ore averaged $6.91 a ton in gold and silver in 1918, as compared with $6.05 a ton in gold and silver in 1917. The average value of all the ore per ton in all metals was $11.69 in 1918, as compared with $10.79 in 1917. The siliceous ore, amounting to 88,723 tons, yielded $762,444 in gold and silver, an average in those metals of $8.59 a ton. The 37,956 tons of copper ore had a value of $112,964 in gold and silver, or an average of $2.97 a ton, and a total value in all metals of $718,365, or $18.92 a ton. The two tons of lead ore averaged $14.50 a ton in silver (no gold), or $63 a ton in lead and silver.

GOLD.

The total recoverable gold content of ores and gravels in Oregon in 1918 was 61,458.74 fine ounces, valued at $1,270,465, a decrease of 10,706.99 ounces in quantity and of $221,333 in value. The largest yield of gold from one county was $1,009,656 and came as usual from Baker County. The next county in rank of production of gold was Grant, with $101,981, or a decrease of $35,739. Other counties of relative rank in production as named were Josephine, Jackson, Crook, Douglas, Umatilla, Clackamas, Lane, Malheur, Wallowa, Curry, and Wheeler. The placer mines of the State produced $498,249 in gold in 1918, as compared with $727,366 in 1917, a decrease of $229,117. The hydraulic mines produced $86,205 in gold in 1918, or $20,786 less than in 1917; the drift mines, $7,449, or $6,099 more; the surface placers and dredges combined, $404,595, or $214,430 less. There were 50 hydraulic mines in 1918, as compared with 46 in 1917; the number of drift mines increased by 3 in 1918, and the number of surface placers by 19. Three dredges were in operation in 1918.

The total output of gold from deep mines in 1918 was 37,355.95 fine ounces, valued at $772,216, which was 376.55 ounces more in quantity and $7,784 more in value than in 1917. Of the gold derived from deep mines $95,233 was recovered by amalgamation, $583,049 by cyanidation, and $93,934 by smelting. Most of the concentrates obtained in milling operations were shipped to smelters for treatment. The siliceous ores of the State yielded $685,413 in gold, and the copper ores, $86,803.

Mine production of gold in Oregon in 1918 in fine ounces.

County.	Placers.	Deep mines.			Grand total.
		Siliceous ore.	Copper ore.	Total.	
Baker	15,073.11	29,970.97	3,798.02	33,768,99	48,842.10
Clackamas		67.00		67.00	67.00
Crook	8.00	1,157.46		1,157.46	1,165.46
Curry	33,86				33.86
Douglas	164.18	37.01		37.01	201.19
Grant	4,687.39	245.94		245.94	4,933.33
Jackson	1,092.98	1,295.97		1,295.97	2,388.95
Josephine	2,802.36	331.51	401.08	732.59	3,534.95
Lane		50.99		50.99	50.99
Malheur	45.81				45.81
Umatilla	138.98				138.98
Wallowa	41.12				41.12
Wheeler	15.00				15.00
	24,102.79	33,156.85	4,199.10	37,355.95	61,458.74
Increase or decrease	−11,083.54	− 1,397.56	+ 1,774.11	+376.55	− 10,706.99

Value of placer gold produced in Oregon in 1918.

County.	Hydraulic.	Drift.	Dredging.	Surface placers.	Total.
Baker	$4,402	$4,509	[a] $387,740	$10,538	[a] $407,189
Crook	165				165
Curry	700				700
Douglas	3,194			200	3,394
Grant	1,088		([a])	209	[a] 1,297
Jackson	19,307	2,770		517	22,594
Josephine	56,653	170		1,107	57,930
Malheur	386			561	947
Umatilla				2,873	2,873
Wallowa				850	850
Wheeler	310				310
	86,205	7,449	387,740	16,855	498,249

[a] Dredging in Grant County included in figures for Baker County.

SILVER.

The recoverable silver content of ores and the silver from placer bullion in Oregon in 1918 aggregated 107,323 fine ounces, valued at $107,323, a decrease of 18,333 ounces. Baker County in 1918 made the largest output of silver, 90,385 ounces. Grant County produced 13,026 ounces. The placer mines of Oregon produced 4,102 ounces, valued at $4,102, as compared with 7,160 fine ounces in 1917. The deep mines produced 103,221 fine ounces. Of this quantity 26,161 ounces were derived from copper ores, and the remainder (with exception of 29 ounces from lead ore), 77,031 ounces, from siliceous ore. By amalgamation 18,019 ounces were recovered and 57,375 ounces by cyanidation. At the smelters 27,827 ounces were recovered.

Mine production of silver in Oregon in 1918, in fine ounces.

County.	Placers.	Deep mines.				Grand total.
		Siliceous ore.	Copper ore.	Lead ore.	Total.	
Baker	3,125	61,291	25,969		87,260	90,385
Clackamas		14			14	14
Crook	1	2,530			2,530	2,531
Curry	5					5
Douglas	21	45			45	66
Grant	408	12,618			12,618	13,026
Jackson	176	419			419	595
Josephine	339	50	192		242	581
Lane		64		29	93	93
Malheur	6					6
Umatilla	10					10
Wallowa	9					9
Wheeler	2					2
	4,102	77,031	26,161	29	103,221	107,323
Increase or decrease	−3,058	−10,090	−5,214	+29	−15,275	−18,333

COPPER.

The mine production of copper in Oregon in 1918 was 2,451,016 pounds, valued at $605,401, as compared with 2,474,487 pounds, valued at $675,535 in 1917, a decrease for 1918 of 23,471 pounds in quantity and $70,134 in value. All the copper came from Baker and Josephine counties.

LEAD.

No production of lead in Oregon was reported in 1917, but 10,601 pounds, valued at $753, was produced in 1918. This came from Baker, Jackson, and Lane counties.

MINING INDUSTRY.

Gold and silver produced in Oregon in 1918, by methods of treatment.

County.	Ore to gold and silver mills.			Ore to concentrating mills.	Concentrates produced.		
	Quantity.	Gold.	Silver.		Quantity.	Gold.	Silver.
	Short tons.		*Fine ounces.*	*Short tons.*	*Short tons.*		*Fine ounces.*
Baker	85,176	$614,718	59,846	33,583	6,876	$82,150	25.239
Clackamas	75	1,385	14				
Crook	919	23,927	2,530				
Douglas	11	765	45				
Grant	378	5,084	12,618				
Jackson	1,782	24,145	221				
Josephine	307	6,853	50				
Lane	21	1,054	64				
	88,669	677,931	75,388	33,583	6,876	82,150	25,239
Average per ton		7.65	$0.851			11.95	$3.67

Gold and silver produced in Oregon in 1918, etc.—Continued.

County.	Crude ore to smelter.			Old tailings treated.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.		*Fine ozs.*	*Short tons.*		*Fine ozs.*
Baker	201	$1,199	2,175			
Clackamas						
Crook						
Douglas						
Grant						
Jackson	10	2,294	192	18	$351	6
Josephine	4,198	8,291	192			
Lane	2		29			
	4,411	11,784	2,588	18	351	6
Average per ton		$2.67	$0.587		$19.50	$0.333

Gold and silver mills in 1918 in Oregon treated 88,669 tons of ore, yielding $677,931 in gold and 75,388 fine ounces of silver, valued at $75,388. From 33,583 tons of ore sent to concentrating plants were recovered 6,876 tons of concentrates, having a value in gold of $82,150, and 25,239 fine ounces of silver, a total of $107,389. Crude ore shipped to smelters amounted to 4,411 tons, which contained $11,784 in gold and 2,588 ounces of silver. There were also 18 tons of tailings treated, which yielded $351 in gold and 6 ounces of silver. The 37,956 tons of copper ore shipped yielded 2,451,016 pounds of copper, or an average of 64.6 pounds a ton.

Ore sold or treated in Oregon in 1918, in short tons.

County.	Silicious ore.	Copper ore.	Lead ore.	Total ore.
Baker	85,202	33,758		118,960
Clackamas	75			75
Crook	919			919
Douglas	11			11
Grant	378			378
Jackson	1,810			1,810
Josephine	307	4,198		4,505
Lane	21		2	23
	88,723	37,956	2	126,681
Increase or decrease	—10,674	—5,085	+2	—15,757
Value per ton in gold and silver	$8.59	$2.97	$14.50	$6.91

Mine production of gold, silver, copper, and lead in Oregon in 1918.

County.	Ore.	Quartz gold.		Placer gold.		Total gold.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ounces.*		*Fine ounces.*		*Fine ounces.*	
Baker	118,960	33,768.99	$698,067	15,073.11	$311,589	48,842.10	$1,009,656
Clackamas	75	67.00	1,385			67.00	1,385
Crook	919	1,157.46	23,927	8.00	165	1,165.46	24,092
Curry				33.86	700	33.86	700
Douglas	11	37.01	765	164.18	3,394	201.19	4,159
Grant	378	245.94	5,084	4,687.39	96,897	4,933.33	101,981
Jackson	1,810	1,295.97	26,790	1,092.98	22,594	2,388.95	49,384
Josephine	4,505	732.59	15,144	2,802.36	57,930	3,534.95	73,074
Lane	23	50.99	1,054			50.99	1,054
Malheur				45.81	947	45.81	947
Umatilla				138.98	2,873	138.98	2,873
Wallowa				41.12	850	41.12	850
Wheeler				15.00	310	15.00	310
	126,681	37,355.95	772,216	24,102.79	498,249	61,458.74	1,270,465

Mine production of gold, silver, copper, and lead in Oregon in 1918—Continued.

County.	Quartz silver.		Placer silver.		Total silver.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*		*Fine ounces.*	
Baker	87,260	$87,260	3,125	$3,125	90,385	$90,385
Clackamas	14	14			14	14
Crook	2,530	2,530	1	1	2,531	2,531
Curry			5	5	5	5
Douglas	45	45	21	21	66	66
Grant	12,618	12,618	408	408	13,026	13,026
Jackson	419	419	176	176	595	595
Josephine	242	242	339	339	581	581
Lane	93	93			93	93
Malheur			6	6	6	6
Umatilla			10	10	10	10
Wallowa			9	9	9	9
Wheeler			2	2	2	2
	103,221	103,221	4,102	4,102	107,323	107,323

County.	Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
Baker	1,655,319	$408,864	7,663	$544	$1,509,449
Clackamas					1,399
Crook					26,623
Curry					705
Douglas					4,225
Grant					115,007
Jackson			1,576	112	50,091
Josephine	795,697	196,537			270,192
Lane			1,362	97	1,244
Malheur					953
Umatilla					2,883
Wallowa					859
Wheeler					312
	2,451,016	605,401	10,601	753	1,983,942

PRODUCTION BY COUNTIES.

BAKER COUNTY.

The total value of all metals mined in Baker County in 1918 was $1,509,449, as compared with $1,689,601 in 1917, a decrease of $180,152. The production of gold from deep mines in 1918 decreased $13,116 and that of copper increased 269,048 pounds. The silver from deep mines increased $9,470 in value, and the lead $544. The total decrease in value of metals from deep mines was $27,310. The placer mines of the county produced $311,589 in gold, or $205,427 less than in 1917. The value of silver from placers in 1918 was $3,125, a decrease of $2,035. There were 42 producing mines of all kinds in the county in 1918, as compared with 21 in 1917. The number of producing deep mines was 20 and of placer mines 22. The total quantity of siliceous ore mined and treated in the county in 1918 was 85,202 tons, or 9,232 tons less than in 1917.

The gold from this ore was valued at $619,555, and the silver amounted to 61,291 fine ounces.

The average recoverable value of the ore per ton in gold and silver was $7.99, as compared with $7.74 per ton in 1917. The 85,176 tons of siliceous ore treated at gold and silver mills produced $614,718 in gold and 59,846 fine ounces of silver, valued at $59,846, an average per ton of $7.92 in gold and silver. From 33,583 tons of ore concentrated were derived 6,876 tons of concentrates producing $82,150 in gold, and 25,239 ounces of silver, valued at $25,239, a total value of $107,389, or an average value per ton of ore of $3.20 and of concentrates of $15.61. The total yield of the 118,759 tons of milling ore from the plates, from direct cyanidation, and from the concentrates, was $696,868 in gold and $85,085 in silver, an average per ton in gold and silver of $6.58. In addition 201 tons of ore was shipped to smelters and yielded $1,199 in gold and $2,175 in silver, a total value of smelting ores of $3,374 in gold and silver, or an average value per ton of $16.79, exclusive of the value of copper.

Auburn district.—This is really now a part of Baker district, but is separated in this chapter to give a better geographic distribution of the various mines. In the Auburn district there were eight productive placer mines and one deep mine. The deep mine is the Broken Gun Barrel, a small producer. Most of the placers are small sluicing properties and include the Begley, Chadsey, Gerhold, Munn, Perry, and Wendell, and the Jayne drift mine. The total value of the output of the district in 1918 was $13,988, of which $13,167 was placer gold.

Baker district.—There is only one productive mining property in the Baker district and that is worked by the Oregon Dredging Co. on Burnt River, near Bridgeport. Operations were continued the full year.

Bull Run Creek district.—In the unorganized district of Bull Run Creek there is only one productive mine, the Whited or Oversight, which was worked in a small way. There is a 10-stamp mill with Wilfley tables on the property, which is operated by water power.

Cable Cove district.—The only productive mines in the Cable Cove district are the Eagle and Miner claims of the Imperial group, which property is equipped with a 100-ton amalgamation and concentration mill. This mill was operated only a part of the year, but the mines were worked continuously. The ore is crushed in jaw crushers and handled on Huntington, Wilfley, and Johnson vanners. The sulphide ores were shipped to smelters for treatment, and the siliceous ore was treated at the mill on the property. The Miner vein was cut at a point 1,200 feet from the portal of the tunnel and approximately 300 feet underground. The mine is developed by some 10,000 feet of workings.

Connor Creek district.—The two producing mines in the Connor Creek district are the Huntington Mining Co.'s hydraulic mine and the Connor Creek quartz mine, both at Home.

Cornucopia district.—The Cornucopia is the most productive gold-mining district in Baker County and in the State of Oregon. There were no productive placers in the district in 1918. The Baker Mines Co. owns a gold mine developed by an adit 2,200 feet in length and 600 feet of shafts. It is equipped with a 20-stamp mill and a 90-ton cyanide plant. The mine of the Cornucopia Mines Co. is developed by a 1,600-foot adit and 800 feet of shafts. The equipment consists of a 20-stamp mill and a 100-ton cyanide plant.

Cracker Creek district.—The two deep mines operating in the Cracker Creek district are the Taber Fraction Mines Co., at Bourne, and the Fraction Mine, near Sumpter. The Taber Fraction has a shaft 300 feet deep, but in 1918 mined its ore through tunnels of the Eureka and Excelsior mines. The mine was only operated from January to May, 1918, and the highly siliceous sulphide ore was shipped to the Tacoma smelter.

Greenhorn district.—There are three deep mines operating in the Greenhorn district and one small placer. The Bonanza Mining Co., at Greenhorn, developed its 300-foot level from January 1 to May 1. It is equipped with a 30-stamp mill and concentrating plant. The other deep mines are the Jones & Evans, and the Golden Eagle.

Iron Dyke district.—In value of all metals the Iron Dyke is the most productive district in Baker County and in the State of Oregon. The values are mainly in copper but there is also considerable gold and silver. The ores from the Copper Dyke mine, formerly the McDougall group, were shipped to smelters in Salt Lake City, Utah. Copper ore from the Goddard & Burmison mine, at Homestead, was shipped to the International smelter. The Homestead-Iron Dyke Mines Co., also at Homestead, the most productive mine in the State, concentrated its copper ores and shipped the concentrates to the International smelter. A few small mines in the district also shipped some copper ore.

Mormon Basin district.—The principal property in the Mormon Basin district is that of the Commercial Mining Co., a large gold producer. It is equipped with a 15-stamp mill and cyanide plant, which were operated the whole year. The placers operating in the district are the Graves, Cartwright, and Rye Valley hydraulic mines, and the Armbuster sluicing mine.

Pine Creek district.—The only productive mines in the Pine Creek district are those of the Burnt River Mining Co. and the Bull Dog, both hydraulic mines.

Sumpter district.—Sumpter is a very productive gold district, mainly owing to the activities of the Powder River Dredge Co., which operated one dredge the entire year. This company closed down the first dredge built on the property at the end of 1917, its ground being worked out. Two other placers were worked in this district in 1918—the Buck Gulch and the Woodwell.

Weatherby district.—Only two small quartz mines were worked in the Weatherby district in 1918—the Little Hill and the Weatherby-Bonanza, both near Weatherby.

Huntington and Robinette districts.—In the unorganized Huntington and Robinette districts there were three productive mines, which were the Wolverton quartz mine, at Huntington, and the Snyder Consolidated Gold Mining Co. (Ltd.), and the Robinette or Frank Johnson, both drift mines, at Robinette.

CLACKAMAS, CROOK, AND CURRY COUNTIES.

The only property reporting production from Clackamas County was the Ogle Mountain Mining Co., on Ogle Creek, near Oregon City. This mine was leased to H. J. Sisty, who commenced the work of opening and developing in May and continued through the year. The mine has a 10-stamp amalgamation and concentration plant and a 50-ton cyanide plant, but the latter was not used in 1918. The concentrates were stored and not shipped.

In Crook County one placer and two deep mines, all in Ochoco district, were productive in 1918. The Ophir-Mayflower Mining Co., at Howard, is worked through an adit 1,435 feet long and two winzes. The company has a 5-stamp mill and concentrators, but they were not used in 1918, the ore having been shipped to the Tacoma smelter. The other deep mine is the Davenport, at Redmond. Water shortage prevented any extended operations in the Ophir-Mayflower Co.'s Ochoco hydraulic mine, at Howard, but old bedrock was cleaned up.

Some production was made by the Foster Creek hydraulic mine at Illahe, in Curry County, but there were no reports received from other mines in this county.

DOUGLAS COUNTY.

The only production from a deep mine in Douglas County was from the Continental, at Nugget. Of the 7 placers, the Boulder hydraulic, at Azalea, only had 40 days' supply of water. The Douglas or Durham, formerly the Tennessee Gulch, hydraulic mine operated in Green Mountain district, near Glendale. In the same district old river-bed gravel was worked in a small way at the Ollala mine. In the Coffee Creek district, near Perdue, old tailings were hydraulicked with a small equipment at the Coffee Creek & Texas mine. In the same district, bench gravel and old tailings were worked by hydraulic process and ground sluicing at the Farquhar mine. The Midget hydraulic mine in the same section had water for only 22 days, so that the yield was small. There was some gold recovered from small placers at Riddle. The entire output of the mines of Douglas County in 1918 was only $4,225.

GRANT COUNTY.

Eight placers and five deep mines in Grant County reported production in 1918, the combined output being $115,007, of which $101,981 was gold and $13,026 silver. Of the placers the Black Butte is a small sluicing proposition in Beech Creek. Near Canyon City are the Quartz Gulch and other small productive hydraulic mines. The Big Nugget is a small hydraulic mine in Olive Creek, near Granite. The Empire Gold Dredging Co. is operating a Bucyrus type of electrically driven dredge, with 6 cubic foot buckets on Canyon Creek near John Day. The dredge worked stream gravel and old tailings about 80 per cent of the time during the year. The property is the most productive in the county. The Dunstan and Maisie Ridge placers are near Susanville. Of the deep mines the Ajax is a small property near Granite. The Ben Harrison, at Granite, was under lease part of 1918. The reduction plant consists of the 20-stamp mill with concentrators and a flotation plant. While the property was under lease the concentrates were sold to the Idaho-Oregon Investment Co., at Baker, Oreg. The ore mined by the company itself was shipped crude to a smelter. The Red Bird mine, at Greenhorn, made a small output, as did the Ward, at Prairie City.

JACKSON COUNTY.

The total output of Jackson County in 1918 was valued at $50,091, of which $49,384 was gold; this was an increase in total value of $32,313 for 1918, as compared with 1917. The output came from 12 producing mines, of which 9 were placers and 3 were deep. Of the deep mines the Gold Hill Mines Association, in Gold Hill district, treated its ore by straight stamping and amalgamation. The Gold Ridge, near Medford, is being developed under lease. The other deep mine is that of the Pearl Mining Co., at Trail, in Elk Creek district. The following hydraulic mines were productive in Applegate district: Pittock, Pacific Placer Co., and Sterling Co. The Duffield & Burns and Galls Creek Mining Co. are hydraulic mines, in Gold Hill district. Some sluicing, hydraulicking, and drift mining was going on at and near Medford, but the mines are small. Most of them had about three months' supply of water.

JOSEPHINE COUNTY.

The total output of Josephine County in gold, silver, and copper in 1918 was valued at $270,192, as compared with $370,981 in 1918, a decrease of $100,789. In 1918 the yield of gold from all mines was $73,074, virtually the same as in 1917, and the value of silver was $581, as compared with $226 in 1917. In 1917 the yield of copper in the county was 1,087,216 pounds, valued at $296,810; in 1918 it was 795,697 pounds, valued at $196,537. This shows that the decrease in total value of the metal output of the county for 1918 was due to the decreased yield and value of the copper, and that the gold mines held their own. Thirty-one productive mines reported in 1918, of which 24 were placers and 7 deep, including 4 copper mines. The deep mines of the county produced in 1918 from 4,505 tons of ore, $15,144 in gold, 242 ounces of silver, and copper valued at $196,537, making a total value from deep mines of $211,923, as compared with $321,588 in 1917. The total output of the placer mines in 1918 was $57,930 in gold and $339 in silver, as compared with $49,222 in gold and $171 in silver in 1917, an increase for 1918 of $8,876 in gold and silver. All the placer mines of the county were operated by the hydraulic method, with the exception of three small sluicing mines and one drift mine. A large proportion of the deep-mine gold of the county was recovered at smelters, and $8,291 of it was derived from copper ores.

Althouse district.—A small quantity of gold was taken in the Althouse district from the Beagle pocket mine, at Holland, by panning, and there was considerable gold obtained from the Boswell mine, at the same place. The production of placer gold came from the Goldsby, Walston, and other small hydraulic mines, at Holland.

Applegate and Chetco districts.—The Oscar Creek Consolidated Mining Co.'s hydraulic mine, at Murphy, and the small placers at the same place were the only producers in Applegate district, and the Chetco placer mine was the only productive one in the district of the same name.

Galice district.—The Corliss & Dean, Horseshoe Bend, and Rocky Gulch hydraulic mines, at Almeda, were the producers in the Galice district.

Grants Pass and Grave Creek districts.—The Granite Hill was the only producer in Grants Pass district. In Grave Creek district the Queen Mining Co., at Leland, shipped copper ore to the Tacoma smelter, and the Columbia Mines Co. made a production of gold from its hydraulic mine, at Placer.

Greenback and Illinois River districts.—The Blue Channel, Story, and Wolf Creek mines, at Wolf Creek, were the placer producers in Greenback district; and the Wilson-Anderson and the Gold Leaf hydraulic mines were those operated in the Illinois River district.

Jump-off-Joe district.—The Ohio, Smith, Swastika and a few small hydraulic mines, all near Grants Pass, were the placer producers of the Jump-off-Joe district, and no deep mines reported production.

Pickett Creek district.—The Farrar or Big Four and other small hydraulic mines at Merlin were the only gold producers in the Pickett district.

Waldo district.—The Waldo was the most productive district in Josephine County in 1918 and yielded in value of all metals $228,697 out of a total for the county of $270,192. The three copper mines were mainly responsible for the supremacy of the district, although most of the gold was from the Waldo Corporation, or Esterly hydraulic mine (formerly the Logan & Simmons) at Waldo. The Queen of Bronze copper mine, at Takilma, was the largest producer in the district. The Waldo Smelting & Mining Co., at Takilma, was worked by lesses, who shipped ore both to the Tacoma smelter, Washington, and to the Mammoth smelter, California. A small quantity of copper ore was also shipped to smelters from the Tan Bark mine, at Takilma

LANE AND MALHEUR COUNTIES.

In Lane County three deep mines were worked productively in 1918. The Atkinson, in the Blue River district, made only a nominal output. The Green Rock Mining Co., in the Bohemia district, has a lead mine which produced ore carrying some zinc also, for which it was penalized. Mining and general improvement of the plant was made after May, 1918. The mine has a 25-ton concentration plant with a Dodge crusher, Chilean mill, and Deister tables. The Noonday is a small gold mine at Cottage Grove. In Malheur County the Glengarry, at Malheur, and the Mormon Basin Placer, at Rye Valley, are small hydraulic mine producers, and there are some few other small placers near Malheur also.

UMATILLA, WALLOWA, AND WHEELER COUNTIES.

Production was reported from small placers at Pendleton, in Umatilla County; Joseph, in Wallowa County; and Antone, in Wheeler County.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN IDAHO.

(MINES REPORT.)

By C. N. Gerry.[1]

PRODUCTION.

GENERAL STATEMENT.

The value of the mine production of gold, silver, copper, lead, and zinc in Idaho in 1918 was $36,522,158, a decrease of more than 33 per cent from the value of 1917. There was a marked decrease in the output of all metals and in the quantity of ore sold or treated. The decrease in the value of the output was even more pronounced, as the average prices of copper, lead, and zinc were much less than those of 1917. In fact, mining conditions in general were discouraging, except the price of silver, which increased to $1 an ounce. Dividends for 1918 amounted to $4,705,036, exclusive of those of the Hercules Mining Co., which are not published.

The production of the State from the discovery of placer gold to the end of 1918 is given in the table below. The total to 1914, inclusive, has been previously given by periods.[2] The complete table shows that the State has been an important producer of the five metals, which have a total value of more than $654,000,000. Of this total, lead represents $300.935,261, or more than 46 per cent; silver, $161,952,182, or nearly 25 per cent; gold, $131,613,785, or more than 20 per cent; copper, $21,175,301, or more than 3 per cent; and zinc, $38,408,834, or nearly 6 per cent.

Mine production of gold, silver, copper, lead, and zinc in Idaho in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	359	2,758,507	$804,809	12,029,338	7,827,574	393,559,521	79,854,136	$54,845,153
1918	301	2,091,619	702,816	9,172,340	6,533,888	294,695,993	45,161,712	36,522,158
Decrease, 1918	....	666,888	101,993	2,856,998	1,293,686	98,863,528	34,692,424	18,322,995
Total, 1863-1918	....	....	131,613,785	233,878,295	122,898,817	6,066,044,245	386,380,352	654,085,363

The table giving the separation according to source of metals shows a distinct decrease in gold from siliceous ore and in silver and lead from lead-zinc ore, but a fair increase in the output of placer gold. The prevailing costs of mining, milling, and transportation made it difficult to market mixed ores profitably.

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[1] Valuable assistance, especially in the compilation of all statistical tables in this report, was rendered by Bessie N. Patchell, of the United States Geological Survey.

[2] U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 598, 1915.

Ore and metals produced in Idaho in 1918.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	85		13,371.33	3,283			
Dry or siliceous ore	73	46,315	14,253.45	69,936	3,703	8,470	
Copper ore	22	127,898	3,339.71	262,991	5,389,887		
Lead ore	116	1,420,878	2,782.34	8,036,861	1,124,503	262,892,200	
Zinc ore	8	5,506	.24	3,114		179,723	3,838,583
Copper-lead ore	1	105		1,706	11,126	10,151	
Lead-zinc ore	16	490,917	251.65	794,449	4,669	31,605,449	41,323,129
		2,091,619	33,998.72	9,172,340	6,533,888	294,695,993	45,161,712

ORE.

The quantity of ore sold or treated in Idaho decreased from 2,758,507 tons in 1917 to 2,091,619 tons in 1918, or about 24 per cent. Most of the output was lead ore and lead-zinc ore, the former being nearly 68 per cent of the total and the latter more than 23 per cent; copper ore represented more than 6 per cent of the total; siliceous ore, more than 2 per cent; and zinc ore and copper-lead ore, less than 1 per cent. Many of the concentration mills, especially in the Coeur d'Alene region, make a separate zinc product which is shipped to a zinc smelter or electrolytic plant, but this class of product decreased considerably in 1918. The total ore mined and treated had an average value per ton in gold and silver of $4.59. The average values in gold and silver for each kind of ore are shown at the foot of the following table. The siliceous ore sold or treated averaged per ton as follows: Gold, $6.36; silver, 1.51 ounces; with a trace of copper and lead. The siliceous ore included 41,481 tons of gold ore, averaging per ton $6.86 in gold and 0.25 ounce of silver; 4,834 tons of silver ore, averaging per ton $2.04 in gold, 12.30 ounces of silver, 0.60 pound of copper, and 1.63 pounds of lead. The copper ore averaged per ton 54 cents in gold and 2.05 ounces of silver, and contained 2.11 per cent of copper. Most of the siliceous ore was treated by amalgamation or cyanidation, and most of the copper ore was shipped directly to smelters. The averages of the crude shipping product are given later. Lead ore as mined averaged 4 cents in gold and 5.66 ounces of silver per ton, and contained 0.04 per cent of copper and 9.25 per cent of lead. The total zinc ore mined or treated averaged per ton 0.56 ounce of silver, and contained 1.63 per cent of lead and 34.86 per cent of recoverable zinc. Copper-lead ore, only 105 tons, averaged per ton 16.25 ounces of silver, and contained 5.30 per cent of copper and 4.83 per cent of lead. Lead-zinc ore averaged per ton 1 cent in gold and 1.62 ounces of silver, and contained a trace of copper, 3.22 per cent of lead, and 4.20 per cent of recoverable zinc. Most of the lead ore and lead-zinc ore was milled, and the results are stated in the text following the table on concentrates.

Ore sold or treated in Idaho in 1918, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Ada	15						15
Adams		169					169
Blaine	92		13,081	1,127		9,400	23,700
Boise	24,630		81				24,711
Bonner			782				782
Boundary			27,973				27,973
Butte			1,215				1,215
Camas	612		28				640
Cassia	13		250	25			288
Clearwater	37						37
Custer	3	54,236	7,955		105		62,299
Elmore	1,270						1,270
Fremont		138					138
Gem	14		15				29
Idaho	15,567						15,567
Latah		167					167
Lemhi	1,853	366	10,034				12,253
Owyhee	2,187						2,187
Shoshone		72,744	1,359,437	4,354		481,517	1,918,052
Valley	22						22
Washington		78	27				105
	[a] 46,315	127,898	1,420,878	5,506	105	490,917	2,091,619
Average value per ton in gold and silver	$7.87	$2.59	$5.70	$0.56	$16.25	$1.63	$4.59

[a] Includes 41,481 tons of gold ore and 4,834 tons of silver ore.

Only about 2 per cent of the ore (40,845 tons) was treated in gold and silver mills in 1918, against 67,677 tons in 1917. Bullion from this ore treated by amalgamation and cyanidation was valued at $224,509, or $5.50 a ton. Boise County led in production of bullion from ore milled, and Idaho County was second. The decrease was general, but it was marked in Idaho, Elmore, and Boise counties. Many of the mines are far from railroad facilities and were unable to operate under the excessive expense of mining. Nearly all the gold in bullion was won by amalgamation, only about 6 per cent being recovered by cyanidation. At these mills during 1918 there were 953 pounds of mercury and 115,600 pounds of sodium cyanide consumed. The average consumption of quicksilver was 0.03 pound per ton of ore amalgamated and 0.057 pound per ounce of gold and silver bullion saved. The cyanide consumption was 1.63 pounds per ton of ore treated and 4.45 pounds per ounce of gold and silver bullion recovered.

Gold and silver produced in mills in Idaho in 1918.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Ada	15	11.08	14			$243
Blaine	53	27.28	50			614
Boise	[a] 22,043	5,623.73	1,204	379.33	82	125,380
Camas	[b] 612	247.16	110			5,219
Clearwater	37	15.34	6			324
Elmore	[c] 1,270	108.53	223	2.28	8	2,521
Idaho	15,560	3,459.18	1,549	278.51	2,759	81,572
Lemhi	[d] 1,044	175.58	55			3,685
Owyhee	[e] 199	36.73	3,885			4,644
Valley	12	14.49	7			307
	40,845	9,719.10	7,103	660.12	2,849	224,509

[a] Also yielded 660 tons of concentrates.

[b] Also yielded 16 tons of concentrates.

[c] Also yielded 53 tons of concentrates.

[d] Also yielded 27 tons of concentrates.

[e] Also yielded 4 tons of concentrates.

Nearly 83 per cent of the ore, or 1,734,718 tons, was concentrated. Concentrates from this ore, from 127,298 tons of old tailings treated, and from a small quantity of ore treated in gold and silver mills aggregated 316,886 tons, valued at $26,187,082, or $82.64 a ton in 1918, against $91.62 a ton in 1917. The concentrates were largely from the Coeur d'Alene region, and the ratio was 5.9 tons of ore to 1 ton of concentrate. Nearly 82 per cent of the total was lead concentrate, 15 per cent lead-zinc concentrate, and less than 3 per cent was zinc concentrate, copper concentrate, and siliceous concentrate. The decrease, amounting to 102,296 tons, was in the lead and zinc products, as there was a slight increase in siliceous and copper concentrates. Operators in Shoshone County shipped an average of 25,670 tons of concentrates of various kinds per month, against 33,967 tons in 1917. The crude ore shipped, which was 9,092 tons per month, being added gives the Coeur d'Alene region average monthly shipments of 34,762 tons of concentrates and crude ore, against 48,910 tons in 1917.

Mine production of metals from Idaho concentrates in 1918.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Blaine	19,197	4,113	397.30	129,177		1,224,754	858,923	$302,510
Boise	2,524	719	2,391.65	25,571	39			73,020
Bonner	775	128		2,195		199,753		16,378
Boundary	27,824	3,478		74,535		4,253,203		376,512
Butte	462	132		660		139,920		10,594
Camas		16	62.50	45		559		1,377
Cassia	250	23	21.40	438	639	15,887		2,166
Custer	28	7		191	15	4,552		518
Elmore		53	309.18	1,230				7,621
Idaho	6	1		318				318
Lemhi	45	36	339.58	98	4,954			8,341
Owyhee	1,950	131	335.26	15,213	907	987		22,438
Shoshone	1,681,647	308,048	1,752.82	5,981,414	1,722,545	215,011,717	40,175,244	25,364,895
Valley	10	1	.89	365	39			394
	1,734,718	316,886	5,610.58	6,229,450	1,729,138	220,851,332	41,034,167	26,187,082

By kinds of concentrates.

Dry or siliceous	948	3,425.28	40,794	985	1,546		$111,954
Copper	3,572	237.58	152,487	1,137,434			438,344
Lead	258,908	1,947.72	5,850,193	590,719	214,862,937		21,291,633
Zinc	5,772		23,152		214,800	3,939,550	396,902
Lead-zinc	47,686		162,824		5,772,049	37,094,617	3,948,249

The concentrates had the following average contents: Siliceous concentrates contained $74.69 in gold and 43.03 ounces of silver, and a value of $118.09 a ton for all metals. Copper concentrates contained $1.37 in gold and 42.69 ounces of silver per ton, and also 15.92 per cent copper, a total value per ton of $122.71. Lead concentrates averaged 16 cents in gold and 22.60 ounces of silver per ton, and

0.11 per cent of copper and 41.49 per cent of lead, or a total value per ton of $82.24. Zinc concentrates averaged 4.01 ounces of silver per ton, 1.86 per cent of lead and 34.13 per cent of recoverable zinc, or a total value per ton of $68.76. Lead-zinc concentrates averaged 3.41 ounces of silver per ton, 6.05 per cent of lead, and 38.89 per cent of recoverable zinc, or a total value per ton of $82.80. Averages for concentrates, as well as for shipping ore, from 1911 to 1914 were given in a previous report.[1]

Of the total ore, 186,551 tons, or nearly 9 per cent, was shipped crude to smelters. The decrease was noticeable in those counties that produced heavily, Shoshone, Custer, and Lemhi. Prior to 1917 most of the crude ore and concentrate was shipped to distant smelting plants outside the State. In 1918 the Bunker Hill smelter, at Bradley, treated a large part of the concentrate and made preparations for enlarging the plant so as to treat more ore when market conditions justified such a course. The total value of the first-class ore was $9,784,537, or $52.45 a ton. The decrease was general, though most pronounced in the lead ore. More than 65 per cent of the crude ore shipped was lead ore, more than 31 per cent was copper ore, and nearly 3 per cent was zinc ore. Siliceous ore, lead-zinc ore, and copper-lead ore constituted less than 1 per cent. The combined value of the concentrates and crude ore shipped was $35,971,619. The ore smelted was principally sulphide in character. A close separation of oxidized and sulphide portions, with average content per ton, is as follows: Copper ore shipped consisted of 30,341 tons of oxidized and carbonate ore, averaging per ton $1.24 in gold and 1.21 ounces of silver, and 4.06 per cent of copper, or a total value per ton of $22.52; and of 27,922 tons of sulphide ore, averaging per ton 95 cents in gold and 2.56 ounces of silver, and 3.19 per cent of copper, or a total value per ton of $19.27. There was a greater difference in the lead ore, for the oxidized portion (17,308 tons) averaged per ton 41 cents in gold and 13.15 ounces of silver, and 0.16 per cent of copper and 24.07 per cent of lead, or a total value per ton of $48.54; and the sulphide lead ore shipped (104,017 tons) averaged per ton 14 cents in gold and 24.51 ounces of silver, and 0.22 per cent of copper and 31.21 per cent of lead, or a total value per ton of $70.06. The oxidized zinc ore (1,152 tons) averaged 27.84 per cent of recoverable zinc, and the sulphide zinc ore (4,069 tons) averaged per ton 0.73 ounce of silver, and 2.19 per cent of lead and 39.08 per cent of recoverable zinc. The lead-zinc ore shipped was sulphide and the copper-lead ore was oxidized.

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[1] U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 601, 1915.

Mine production of metals from Idaho crude ore shipped to smelters in 1918.

By counties.

County.	Quantity.	Gold.	Silver.	Copper.	Lead.	Revocerable zinc.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Adams	169	....	299	41,304	....	....	$10,501
Blaine	2,293	162.27	84,562	3,228	749,733	630,160	199,289
Boise	144	83.25	4,029	2,878	30,501	....	8,627
Bonner	7	.05	100	189	5,977	....	572
Boundary	149	....	2,683	....	151,119	....	13,412
Butte	753	6.44	7,770	2,030	461,662	....	41,182
Camas	28	15.47	633	222	8,754	....	1,630
Cassia	38	1.58	230	....	454	11,315	1,325
Custer	62,221	2,526.34	194,914	3,539,533	3,038,466	....	1,337,134
Fremont	138	....	87	23,303	....	....	5,843
Gem	29	13.59	1,798	....	2,224	....	2,237
Idaho	1	....	319	....	....	....	319
Latah	167	5.95	189	79,044	....	....	19,836
Lemhi	11,164	623.20	136,519	98,709	5,454,251	....	561,035
Owyhee	38	48.38	11,636	....	....	....	12,636
Shoshone	109,107	1,105.95	2,463,758	983,990	63,601,521	3,486,070	7,562,606
Washington	105	.29	2,964	5,313	29,162	....	6,353
	186,551	4,592.76	2,912,490	4,779,743	73,533,824	4,127,545	9,784,537

By kinds of ore.

Dry or siliceous	980	448.94	19,190	2,718	6,924	....	$29,635
Copper	58,263	3,102.15	107,978	4,247,003	....	....	1,221,115
Lead	121,325	1,036.23	2,777,212	518,896	73,250,547	....	8,127,589
Zinc	5,221	.24	3,062	....	177,923	3,822,040	363,506
Copper-lead	105	....	1,706	11,126	10,151	....	5,175
Lead-zinc	657	5.20	3,342	....	88,279	305,505	37,518

The crude ore shipped had the following averages: Siliceous ore averaged $9.47 in gold and 19.58 ounces of silver per ton and 0.14 per cent of copper and 0.35 per cent of lead, or a total value per ton of $30.24; copper ore averaged $1.10 in gold and 1.85 ounces of silver per ton, and 3.64 per cent of copper, or a total value per ton of $20.96; lead ore averaged 18 cents in gold and 22.89 ounces of silver per ton, and 0.21 per cent of copper and 30.19 per cent of lead, or a value per ton of $66.99; zinc ore averaged 0.59 ounce of silver, 1.70 per cent of lead, and 36.60 per cent of recoverable zinc, or a total value per ton of $69.62; lead-zinc ore averaged 16 cents in gold and 5.09 ounces of silver per ton, and 6.72 per cent of lead and 23.25 per cent of recoverable zinc, or a total value per ton of $57.11. Copper-lead ore smelted (105 tons) averaged 16.25 ounces of silver per ton, and 5.30 per cent of copper and 4.83 per cent of lead, or a total value per ton of $49.28.

GOLD.

The mine production of gold in Idaho in 1918 was 33,998.72 fine ounces, valued at $702,816, a decrease of $101,993, or nearly 13 per cent. The mines of Shoshone County had the largest output of gold on account of dredge operations, but the output of Boise County, usually first, was nearly as large. Other counties having large production of gold were Idaho, Custer, and Lemhi. The large increase in the output of Shoshone County did not entirely compensate for the aggregate decrease in Idaho, Elmore, and Lemhi counties. The lode mines, 216 in number, produced gold valued at $426,406, and 85 placers produced gold valued at $276,410, against 112 placers and $135,231 in 1917. Of the placer gold, $239,762 was won by dredges, $18 by drift mines, and $36,630 by hydraulic or slucing mines. The output by dredges in 1918 increased $180,315 over that of 1917, and gold recovered by sluicing and hydraulicking decreased $39,102. Of the total gold, more than 39 per cent came from placers, nearly 42 per cent from siliceous ore, more than 8 per cent from lead ore, nearly 10 per cent from copper ore, and less than 1 per cent from lead-zinc ore. Siliceous ores contained $6.36 a ton in gold; copper ore, 54 cents; lead ore, 4 cents; and lead-zinc ore, 1 cent. Snake River in various counties produced only $1,218 in gold, against $917 in 1917. The production of gold from amalgamation and cyanidation mills was less than half of that of 1917. In 1918 bullion recovered in these mills contained 10,379.22 ounces of gold, or more than 30 per cent of the total, against 22,721.08 ounces in 1917. Amalgamation won 9,719.10 ounces of gold and cyanidation 660.12 ounces. Concentrates of all kinds contained only 5,610.58 ounces of gold, or nearly 17 per cent of the total gold, and crude ore shipped to smelters contained 4,592.76 ounces of gold, or nearly 14 per cent of the total. Various sulphide shipping ores contained 1,976.12 ounces of gold and oxidized ores contained 2,616.64 ounces. A statement of dredges operated since 1897 and their output by years was given in a former report.[1] A total of $4,021,265 has been recovered by dredges.

In 1918 there were only 5 mines which had a gold output of more than $35,000 each. In order of their importance these were the Yukon Gold Co., at Murray; Gold Hill & Iowa Mines Co., at Quartzburg; Empire Copper Co., at Mackay; Holte mine, at Burgdorf; and the Boston-Idaho Dredging Co., at Idaho City.

Mine production of gold in Idaho in 1918, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total
Ada	47.02	11.08					58.10
Adams	18.19						18.19
Benewah	34.06						34.06
Bingham	2.37						2.37
Blaine	2.71	28.08		470.60		133.00	634.39
Boise	2,493.15	8,450.53		27.43			10,971.11
Bonner				.05			.05
Bonneville	108.31						108.31
Butte				6.44			6.44
Camas		309.66		15.47			325.13
Cassia		1.34		21.40	.24		22.98
Clearwater	218.99	15.34					234.33
Custer	50.31	11.80	2,479.10	35.44			2,576.65
Elmore	57.23	419.99					477.22
Fremont	.77						.77
Gem		2.79		10.80			13.59
Idaho	231.91	3,737.69					3,969.60
Latah			5.95				5.95
Lemhi	836.74	829.40	16.48	292.48			1,975.10
Nez Perce	6.43						6.43
Owyhee	2.52	420.37					422.89
Power	10.40						10.40
Shoshone	9,014.87		838.18	1,901.94		118.65	11,873.64
Twin Falls	14.66						14.66
Valley	220.69	15.38					236.07
Washington				.29			.29
	13,371.33	[a]14,253.45	3,339.71	2,782.34	.24	251.65	33,998.72

[a] Includes 13,774.92 ounces from gold ore and 478.53 ounces from silver ore.

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[1] U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 604, 1915.

SILVER.

The mine production of silver in Idaho decreased from 12,029,338 ounces in 1917 to 9,172,340 ounces in 1918, and the value from $9,912,175 to $9,172,340—a decrease of nearly 24 per cent in quantity but of only about 7 per cent in value. Fair increase was made in Blaine County, but there was a decrease of 2,793,907 ounces in Shoshone County. A separation of the silver according to source shows that the largest part of the total silver yield, or more than 87 per cent, was from lead ore, nearly 9 per cent from lead-zinc ore, nearly 3 per cent from copper ore, and less than 1 per cent from siliceous ore, zinc ore, copper-lead ore, and placers. Shoshone County produced more than 92 per cent of the silver. Concentrates supplied nearly 68 per cent of the silver, shipping ore contained nearly 32 per cent, and gold and silver bullion contained only 0.11 per cent. Crude shipping ore averaged 15.61 ounces of silver a ton and concentrates 19.66 ounces a ton. The silver contents of the different kinds of shipping ore have already been given. The Banner mine in Boise County and the Trade Dollar and Demming mines in Owyhee County produced ore in which the silver was far more valuable than the gold. Much silver ore was formerly produced in Owyhee County.

Eleven mines in Idaho produced a total of 8,234,962 ounces of silver in 1918, or about 90 per cent of the total; they were the Hercules, Hecla, Bunker Hill, Morning, Tamarack & Custer, Caledonia, Gold Hunter, Consolidated Interstate-Callahan, Independence, National, and Sierra Nevada mines. Each of these produced more than 100,000 ounces of silver and three of them produced more than 1,000,000 ounces.

Mine production of silver in Idaho in 1918, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Ada	9	14						23
Adams	4		299					303
Benewah	3							3
Blaine		1,857		201,236			25,335	228,428
Boise	692	27,884		1,002				29,578
Bonner				2,295				2,295
Bonneville	3							3
Boundary				77,218				77,218
Butte				8,430				8,430
Camas		155		633				788
Cassia		159		438	71			668
Clearwater	70	6						76
Custer	56	494	105,111	90,320		1,706		197,687
Elmore	12	1,461						1,473
Fremont			87					87
Gem		1,313		485				1,798
Idaho	42	4,945						4,987
Latah			189					189
Lemhi	199	542	164	135,966				136,871
Nez Perce	1							1
Owyhee	1	30,734						30,735
Shoshone	2,047		154,348	7,518,667	3,043		769,114	8,447,219
Twin Falls	3							3
Valley	141	372						513
Washington			2,793	171				2,964
	3,283	[a]69,936	262,991	8,036,861	3,114	1,706	794,449	9,172,340

[a] Includes 10,466 ounces from gold ore and 59,470 ounces from silver ore.

COPPER.

The mine production of copper in Idaho decreased from 7,827,574 pounds, valued at $2,136,928, in 1917, to 6,533,888 pounds, valued at $1,613,870, in 1918 a decrease of nearly 17 per cent in quantity and more than 24 per cent in value. More than half of the copper came from Custer County and about 41 per cent from Shoshone County. The Empire property, near Mackay, is still the largest copper producer in the State. In the Coeur d'Alene region the National and Richmond mines added considerable copper to the State output. More than 82 per cent of the total output was from copper ore, about 17 per cent from lead ore, and less than 1 per cent from copper-lead, lead-zinc, and siliceous ores. Concentrates contained more than 26 per cent of the copper, and crude shipping ore of all kinds 73 per cent. Crude copper ore of shipping grade averaged 3.64 per cent of copper, and copper concentrates 15.92 per cent. Smelting sulphide ore contained 3.19 per cent of copper, and oxidized ore 4.06 per cent. The average price of copper decreased from 27.3 cents a pound in 1917 to 24.7 cents in 1918. The following five mines produced more than 200,000 pounds each and a total of more than 6,000,000 pounds: Empire, National, Richmond, Hercules, and Caledonia mines.

Mine production of copper in Idaho in 1918, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Adams		41,304				41,304
Blaine			22,785			22,785
Boise	2,067		850			2,917
Bonner			189			189
Butte			2,030			2,030
Camas			222			222
Cassia			639			639
Custer		3,518,063	15,809	11,126		3,544,998
Fremont		23,303				23,303
Latah		79,044				79,044
Lemhi	690	64,648	38,325			103,663
Owyhee	907					907
Shoshone		1,658,212	1,043,654		4,669	2,706,535
Valley	39					39
Washington		5,313				5,313
	[a]3,703	5,389,887	1,124,503	11,126	4,669	6,533,888

[a] Includes 690 pounds from gold ore and 3,013 pounds from silver ore.

LEAD.

The mine production of lead decreased from 393,559,521 pounds, valued at $33,846,119, in 1917 to 294,695,993 pounds, valued at $20,923,416, in 1918. The decrease in quantity was more than 25 per cent and in value more than 38 per cent. The output of 1917 was a record for the State and was close to the output of Missouri, the leading lead producer of the United States. The value of the output of lead in 1918 was greater than the combined value of the output of gold, silver, copper, and zinc. Aside from Shoshone County, which supplied about 95 per cent of the total output, good production was made by Lemhi, Boundary, Custer, and Blaine counties. Lead ore supplied more than 89 per cent of the total and lead-zinc ore nearly 11 per cent. The recoverable lead in lead ores sold or treated averaged 9.25 per cent, and that in lead-zinc ore 3.22 per cent. Crude lead ore of shipping grade averaged 30.19 per cent of recoverable lead, and lead concentrates 41.49 per cent. Concentrates of all kinds produced nearly 75 per cent of the total. Lead concentrates had an average value per ton of $82.24. Crude ore shipped was the source of nearly 25 per cent of the lead, and the lead ore shipped to smelter had an average value per ton of $66.99. Nearly all the lead in crude ore shipped was from sulphide ores, only 8,332,600 pounds coming from oxidized ores. The average price of lead for 1918 decreased 1.5 cents from the price in 1917.

Fifteen mines produced more than 96 per cent of the State output of lead in 1918. These were the Bunker Hill, Hercules, Hecla, Morning, Tamarack & Custer, Gold Hunter, Consolidated Interstate-Callahan, Caledonia, Idaho Continental, Sierra Nevada, Last Chance, Latest Out, Pittsburg Idaho, Red Bird, and Independence mines. Each one produced more than 1,000,000 pounds of lead, and the first six produced more than 10,000,000 pounds.

Mine production of lead in Idaho in 1918, in pounds.

County.	Dry or siliceous ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Blaine	2,998	1,836,867			445,459	2,285,324
Boise	2,789	27,712				30,501
Bonner		205,730				205,730
Boundary		4,404,322				4,404,322
Butte		601,582				601,582
Camas	559	8,754				9,313
Cassia	454	15,887				16,341
Custer		3,032,867		10,151		3,043,018
Gem	683	1,541				2,224
Lemhi		5,454,251				5,454,251
Owyhee	987					987
Shoshone		247,273,525	179,723		31,159,990	278,613,238
Washington		29,162				29,162
	[a] 8,470	262,892,200	179,723	10,151	31,605,449	294,695,993

[a] Includes 559 pounds from gold ore and 7,911 pounds from silver ore.

ZINC.

The mine production of recoverable zinc decreased from 79,854,136 pounds, valued at $8,145,122, in 1917 to 45,161,712 pounds, valued at $4,109,716, in 1918. The decrease of 34,692,424 pounds in quantity and of $4,035,406 in value was almost entirely in the Coeur d'Alene region. The Consolidated Interstate-Callahan property retained first place among the zinc producers of the State. The output of zinc from Blaine County was important notwithstanding a marked decrease. Zinc remains an important product of Idaho, as will be seen from the value, which is more than the combined value of the gold and copper, but less than half the value of the silver. Lead-zinc ore supplied nearly 92 per cent and zinc ore more than 8 per cent of the zinc. Both the zinc concentrates and the crude zinc ore shipped are sulphide products, except the 1,152 tons from Blaine and Cassia counties. From concentrates, both zinc and lead-zinc, 41,034,167 pounds of recoverable zinc were won, or nearly 91 per cent of the total; and from crude ore shipped, 4,127,545 pounds were won, or more than 9 per cent of the total. Flotation is used extensively in the treatment of zinc ore, and especially in the re-treatment of old tailings containing zinc and lead. Most of the zinc material was treated in eastern smelters, but some was roasted and leached at Great Falls, Mont. The average price of metallic zinc was 9.1 cents a pound in 1918, 1.1 cents less than the price in 1917.

Nine mines produced more than 250,000 pounds of recoverable zinc each in 1918. Named in order of importance, these were the Consolidated Interstate-Callahan, Morning, Success, Amazon-Manhattan, North Star, Kusa, Frisco, Hecla, and Hercules mines.

Mine production of recoverable zinc in Idaho in 1918, in pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Blaine	630,160	858,923	1,489,083
Cassia	11,315		11,315
Shoshone	3,197,108	40,464,206	43,661,314
	3,838,583	41,323,129	45,161,712

The sources of the ore and the actual assay in zinc, without deduction for losses in smelting, are shown below. There were 59,336 tons of zinc ore, zinc concentrates, lead-zinc ore, and lead-zinc concentrates shipped, of which the gross content was 51,988,862 pounds of zinc, or an average of 43.81 per cent. Most of the output came from Beaver, Hunter, Lelande, Placer Center, and Yreka districts, in Shoshone County, and the Warm Springs district in Blaine County. In 1917 the shipments were 117,521 tons of zinc ore and concentrates containing 93,964,203 pounds of zinc, or an average of 39.98 per cent.

Zinc ore, lead-zinc ore, and concentrates produced from Idaho mines sold in 1918.

Classification.	County.	Quantity (short tons, dry weight).	Average assay of ore and concentrate (percentage of zinc).[a]
Sulphide zinc ore and concentrates	Shoshone	9,841	42.67
Sulphide lead-zinc ore and concentrates	Blaine and Shoshone	48,343	44.30
Carbonate zinc ore	Blaine and Cassia	1,152	32.76
		59,336	43.81

[a] Actual zinc content.

REDUCTION PLANTS.

In Idaho 62 milling plants of all kinds were in operation in 1918, against 69 active mills in 1917. Of these mills 38 were concentration plants, 21 of which used flotation machines with other concentrating devices, 5 used flotation alone, and 12 used crushers, jigs, and tables without flotation cells; 15 used amalgamation alone; 2 used cyanidation; 5 used amalgamation and concentration; 1 used amalgamation and cyanidation; and 1 used amalgamation, concentration, and cyanidation. Several other mills were under construction. Much of the ore and concentrate is now smelted at Bradley, Idaho, instead of being shipped to distant plants.

MINING INDUSTRY.

The value of the output of gold, silver, copper, lead, and zinc in Idaho in 1918 shows that the mining industry suffered greatly from the burdens imposed by the war, as well as from other causes. A decrease of 33 per cent was the result of the shortage of labor, higher wages, excessive costs of supplies, increased freight rates, floods that interrupted transportation, and the epidemic of influenza. The market for mine products was not so good as in 1917. The price of silver was higher, but the prices of copper, lead, and zinc were lower. Idaho and Washington suffered even more than some of the other Western States. The decrease in Utah and Oregon was about 13 per cent, California 18 per cent, and the value of the output in Montana was even better than that of 1917.

In the Coeur d'Alene region floods delayed shipments from the western part of the district and washed out parts of the Beaver Creek branch of the Oregon-Washington Railroad & Navigation Co., preventing shipments for several months. In Pine Creek the branch line under construction was damaged by washouts and was not completed for operation in 1918. There were other features of the year, however, that gave encouragement to the mining industry. Greatly improved ore resources were noted at several of the large mines of the State, especially the Tamarack & Custer, Hecla, Hercules, Morning, and Bunker Hill mines, and the successful and constant operation of the Bunker Hill smelter and refinery lent a solidity and completeness to the State's operations that it has never before enjoyed.

Mine production of gold, silver, copper, lead, and zinc in Idaho in 1918.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.		
	Quantity.	Value.	Quantity.	Value.		Quantity.	Value.
	Fine ounces.		*Fine ounces.*			*Fine ounces.*	
Ada	47.02	$972	11.08	$229	$1,201	23	$23
Adams	18.19	376			376	303	303
Benewah	34.06	704			704	3	3
Bingham	2.37	49			49		
Blaine	2.71	56	631.68	13,058	13,114	228,428	228,428
Boise	2,493.15	51,538	8,477.96	175,255	226,793	29,578	29,578
Bonner			.05	1	1	2,295	2,295
Bonneville	108.31	2,239			2,239	3	3
Boundary						77,218	77,218
Butte			6.44	133	133	8,430	8,430
Camas			325.13	6,721	6,721	788	788
Cassia			22.98	475	475	668	668
Clearwater	218.99	4,527	15.34	317	4,844	76	76
Custer	50.31	1,040	2,526.34	52,224	53,264	197,687	197,687
Elmore	57.23	1,183	419.99	8,682	9,865	1,473	1,473
Fremont	.77	16			16	87	87
Gem			13.59	281	281	1,798	1,798
Idaho	231.91	4,794	3,737.69	77,265	82,059	4,987	4,987
Latah			5.95	123	123	189	189
Lemhi	836.74	17,297	1,138.36	23,532	40,829	136,871	136,871
Nez Perce	6.43	133			133	1	1
Owyhee	2.52	52	420.37	8,690	8,742	30,735	30,735
Power	10.40	215			215		
Shoshone	9,014.87	186,354	2,858.77	59,096	245,450	8,447,219	8,447,219
Twin Falls	14.66	303			303	3	3
Valley	220.69	4,562	15.38	318	4,880	513	513
Washington			.29	6	6	2,964	2,964
	13,371.33	276,410	20,627.39	426,406	702,816	9,172,340	9,172,340

Mine production of gold, silver, copper, lead, and zinc in Idaho in 1918—Continued.

County.	Copper.		Lead.		Recoverable zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Ada							$1,224
Adams	41,304	$10,202					10,881
Benewah							707
Bingham							49
Blaine	22,785	5,628	2,285,324	$162,258	1,489,083	$135,506	544,934
Boise	2,917	720	30,501	2,166			259,257
Bonner	189	47	205,730	14,607			16,950
Bonneville							2,242
Boundary			4,404,322	312,707			389,925
Butte	2,030	501	601,582	42,712			51,776
Casmas	222	55	9,313	661			8,225
Cassia	639	158	16,341	1,160	11,315	1,030	3,491
Clearwater							4,920
Custer	3,544,998	875,614	3,043,018	216,054			1,342,619
Elmore							11,338
Fremont	23,303	5,756					5,859
Gem			2,224	158			2,237
Idaho							87,046
Latah	79,044	19,524					19,836
Lemhi	103,663	25,605	5,454,251	387,252			590,557
Nez Perce							134
Owyhee	907	224	987	70			39,771
Power							215
Shoshone	2,706,535	668,514	278,613,238	19,781,540	43,661,314	3,973,180	33,115,903
Twin Falls							306
Valley	39	10					5,403
Washington	5,313	1,312	29,162	2,071			6,353
	6,533,888	1,613,870	294,695,993	20,923,416	45,161,712	4,109,716	36,522,158

It appears from the following table that the total output of gold from placer mines was more than doubled in 1918, although the output from most of the counties decreased markedly. The increase was due to the results from the operations of dredges at Murray. The total was rather a return to a normal output, as the total in 1917 was especially low on account of the idleness of the dredge at Idaho City.

Producing placer mines and their production of gold and silver in Idaho in 1917 and 1918.

County.	1917						1918					
	Mines.						Mines.					
	Hydraulic.	Dredge.	Drift.	Gold.	Silver.	Total value.	Hydraulic.	Dredge.	Drift.	Gold.	Silver.	Total value.
					Fine ounces.						*Fine ounces.*	
Ada	4	....	....	$5,512	57	$5,559	2	....	....	$972	9	$981
Adams	....	....	....	....	....	....	1	....	....	376	4	380
Benewah	2	....	....	3,182	23	3,201	1	....	....	704	3	707
Bingham	1	....	....	260	....	260	1	....	....	49	....	49
Blaine	....	....	....	....	....	....	1	....	....	56	....	56
Boise	22	....	....	38,340	452	38,713	18	1	....	51,538	692	52,230
Bonneville	1	....	....	2,163	3	2,165	1	....	....	2,239	3	2,242
Clearwater	8	1	....	17,349	187	17,503	9	1	....	4,527	70	4,597
Custer	6	....	....	1,750	33	1,777	5	....	....	1,040	56	1,096
Elmore	5	....	....	956	16	969	4	....	....	1,183	12	1,195
Fremont	....	....	....	....	....	....	1	....	....	16	....	16
Gem	1	....	....	14	....	14	....	....	....	....	....	....
Gooding	1	....	....	34	....	34	....	....	....	....	....	....
Idaho	32	....	....	11,429	129	11,535	15	....	1	4,794	42	4,836
Latah	2	....	....	271	1	272	....	....	....	....	....	....
Lemhi	5	2	1	41,397	161	41,530	4	2	1	17,297	199	17,496
Lincoln	2	....	....	97	....	97	....	....	....	....	....	....
Nez Perce	1	....	....	14	....	14	1	....	....	133	1	134
Owyhee	1	....	....	8	....	8	2	....	....	52	1	53
Power	3	....	....	233	....	233	2	....	....	215	....	215
Shoshone	5	1	....	11,910	130	12,017	4	1	....	186,354	2,047	188,401
Twin Falls	3	....	....	251	1	252	3	....	....	303	3	306
Valley	2	....	....	61	1	62	3	....	....	4,562	141	4,703
	107	4	1	135,231	1,194	136,215	78	5	2	276,410	3,283	279,693

There were fewer active deep mines, less ore was produced, and the value of the ore decreased $2.50 a ton in 1918, as compared with 1917.

Ores sold or treated, deep mines producing, and average value of ores in Idaho in 1917 and 1918.

County.	Ore sold or treated in 1918.		Number of deep mines producing.		Average total value per ton.		Average value per ton in gold and silver.	
	Quantity.	Increase or decrease.	1917	1918	1917	1918	1917	1918
	Short tons.	*Short tons.*						
Ada	15	− 5	2	1	$16.40	$16.20	$16.40	$16.20
Adams	169	+ 4	3	3	52.18	62.13	.76	1.77
Blaine	23,700	+ 2,970	31	34	24.48	22.99	6.71	10.19
Boise	24,711	− 2,879	11	10	7.40	8.38	7.22	8.26
Bonner	782	+ 1	2	2	27.70	21.68	5.66	2.94
Bonneville	....	− 2	1	......	96.00	....	15.00	....
Boundary	27,973	−10,618	4	2	17.13	13.94	2.61	2.76
Butte	1,215	− 4,683	8	2	44.26	42.61	5.47	7.05
Camas	640	− 359	8	5	9.17	12.85	8.78	11.73
Cassia	288	+ 141	2	3	25.97	12.12	15.53	3.94
Clearwater	37	+ 37	......	2	....	8.73	....	8.73
Custer	62,299	− 21,404	27	27	20.77	21.53	3.06	4.01
Elmore	1,270	− 24,346	8	4	4.18	7.99	4.18	7.99
Fremont	138	− 587	3	1	76.88	42.34	1.16	.63
Gem	29	+ 25	1	2	15.25	77.14	15.25	71.69
Idaho	15,567	+ 4,216	24	22	18.19	5.27	18.02	5.27
Latah	167	+ 108	1	1	86.97	118.77	1.34	1.87
Lemhi	12,253	− 6,795	34	32	43.78	46.77	7.87	13.07
Owyhee	2,187	+ 1.316	17	12	42.97	18.17	42.14	18.03
Shoshone	1,918,052	−604,075	60	47	19.84	17.17	3.70	4.43
Valley	22	− 30	4	2	26.42	31.82	26.42	31.36
Washington	105	+ 77	1	2	97.39	60.50	4.93	28.29
	2,091,619	−666,888	247	216	19.83	17.33	3.84	4.59

Classifying the deep mines according to the metals produced in 1918 shows that there were 5 mines producing gold only; 3 silver only; 53 gold and silver; 4 copper only; 11 gold, silver, and copper; 43 gold, silver, copper, and lead; 5 gold, silver, copper, lead, and zinc; 23 gold, silver, and lead; 12 silver, copper, and lead; 33 silver and lead; 7 silver and copper; 12 silver, lead, and zinc; 3 gold, silver, lead, and zinc; 1 zinc alone; and 1 gold, silver, and zinc.

REVIEW BY COUNTIES.

ADA COUNTY.

The value of the mine output decreased from $5,887 in 1917 to $1,224 in 1918. Most of the gold came from the Charcoal placers in the Highland district.

ADAMS COUNTY.

Except a small production from placers, the output of the county consisted of copper ore shipped from 3 properties. The value of the output was $10,881, against $8,610 in 1917.

Seven Devils district.—Several shipments of copper ore were made from the River Queen and Azurite properties.

Unorganized district.—A small placer production came from the vicinity of Cuprum.

BENEWAH COUNTY.

Camas Cove district.—The placer production of this region, near Tyson, decreased from $3,182 in gold and 23 ounces of silver in 1917 to $704 in gold and 3 ounces of silver in 1918.

BINGHAM COUNTY.

The output of placer gold from Bingham County was unimportant. In former years the banks of Snake River yielded much gold, but in 1918 the output from Bingham County and other counties through which the river runs was only $1,218 in gold.

BLAINE COUNTY.

Mine production in Blaine County, Idaho, in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	31	20,730	$10,455	156,056	19,416	1,710,133	2,118,375	$507,491
1918	35	23,700	13,114	228,428	22,785	2,285,324	1,489,083	544,934
Increase or decrease, 1918		+2,970	+2,659	+72,372	+3,369	+575,191	−629,292	+37,443
Total, 1880–1918			2,478,972	15,802,591	232,586	183,862,288	7,997,090	25,452,363

There was a fair increase in Blaine County in production of ore and of all metals except zinc. Thirty-four deep mines produced 23,700 tons of ore, which had a total value per ton of $22.99 and a value per ton in gold and silver of $10.19. The ore was divided into 13,081 tons of lead ore, 9,400 tons of lead-zinc ore, 1,127 tons of zinc ore, and 92 tons of siliceous ore. Most of the ore, 19,197 tons, was concentrated and produced 4,113 tons of concentrates valued at $302,510, or $73.55 a ton. There were 2,293 tons of crude ore shipped valued at $199,289, or $86.91 a ton. From 1880 to 1918 this county has produced $2,478,972 in gold, $14,306,605 in silver, $43,676 in copper, $7,974,561 in lead, and $648,549 in zinc, a total of $25,452,363. The output of the county by years to 1914 was published in this report[1] for that year.

Galena district.—The only output of the district was a test shipment of lead ore.

Mineral Hill district.—The output of the district from 15 deep mines and 1 placer was 299 tons of ore, $1,155 in gold, 9,735 ounces of silver, 732 pounds of copper, and 120,147 pounds of lead, in all valued at $19,601. The ore had a value per ton of $65.37. Most of the ore, or 232 tons, was lead ore shipped directly to the smelters. The output was made up of small shipments from various properties, as no large producing mine was operated in the district.

Warm Springs district.—Eighteen deep mines produced 23,399 tons of ore, containing $11,951 in gold, 218,394 ounces of silver, 22,027 pounds of copper, 2,162,871 pounds of lead, and 1,489,083 pounds of recoverable zinc, valued in all at $524,856, or an average value per ton of $22.43. The output was separated into 19,197 tons of ore milled, which made 4,113 tons of concentrates, 2,059 tons of crude ore, and some old slag. The most important producers of the district were the North Star mine—which was operated by the Federal Mining & Smelting Co. during May, June, July, and August—the Lake Creek property, and the Independence mine. At the North Star property the output was less than in 1917 because the mill was being overhauled on account of the difficulty in treating the complex lead-zinc ore. The company mined 9,700 tons of ore and made the following statement[2] regarding the mine:

> The operations on this property disclosed a considerable body of ore, but the metallurgical difficulties are so great at present costs and prices that a satisfactory profit could not be made. It was, therefore, determined to close down the mine.

The Independence property was taken over by the Federal Mining & Smelting Co., and operated the entire year. This ore is successfully treated by concentration and operations promised to show a satisfactory profit. Ore reserves at the end of the year were 51,600 tons of milling ore equal to about 7,950 tons of concentrate and 4,120 tons of first-class ore. The mill was remodeled and produced high-grade lead concentrate. More than 1,000 tons of oxidized zinc ore was shipped from the Lake Creek property, but later the mine was closed on account of the depletion of the ore body. Other producing properties of the district were the Homestake, Mascot, Last Chance, Golden Glow, L. and S., and Woodrow Wilson mines. Development work at the Black Barb mine opened a body of lead-zinc ore containing silver.

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[1] U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 613, 1915.

[2] Federal Mining & Smelting Co. Ann. Rept. for year ending Dec. 31, 1918.

BOISE COUNTY.

Mine production in Boise County, Idaho, in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	33	27,590	$217,486	24,778	4,323	43,821	$242,852
1918	29	24,711	226,793	29,578	2,917	30,501	259,257
Increase or decrease, 1918	....	−2,879	+9,307	+4,800	−1,406	−13,320	+16,405

[a] Includes placer production.

There was an increase in the output of gold and silver in Boise County in 1918, though less ore was mined and treated. Ten deep mines produced 24,711 tons of ore, containing $175,255 in gold, 28,886 ounces of silver, 2,917 pounds of copper, and 30,501 pounds of lead, valued in all at $207,027, or $8.38 per ton. Of the ore, 22,043 tons were treated in gold and silver mills, and only 144 tons were shipped to smelters. Bullion in the ore milled was valued at $125,380, or $5.69 a ton in gold and silver. All of the output was siliceous, except 81 tons, which was lead ore. In 1918 there were 19 placer operators, who produced only $51,538 in gold and 692 ounces of silver, having a total value of $52,230. The large dredge of the Boston Idaho Co. was active only a short time in 1918. Late in the year the boat was moved to California, as the available ground had been worked. In 1917 there were 22 placer mines, producing $38,340 in gold and 452 ounces of silver.

The production of gold and silver in the county, exclusive of copper and lead, from 1863 to the end of 1918 was $52,329,132 in gold and 2,181,444 ounces of silver, or a total value of $54,637,264. The output by years to 1914 was given in the report[1] for that year.

Banner district.—The Banner group produced several thousand tons of silver ore treated in a concentration plant equipped with flotation machines.

Boise Basin district.—Nine deep mines and 18 placers produced 22,187 tons of ore, $226,635 in gold, 8,511 ounces of silver, 2,878 pounds of copper, and 30,501 pounds of lead, valued in all at $238,022. With the exception of 144 tons of ore shipped directly to smelters, all the ore was treated in gold and silver mills and resulted in bullion and concentrates. The Gold Hill & Iowa Mines Co. was next to the largest producer of gold in the State. The ore is treated in a 100-ton concentrator equipped with ball mill, Hardinge mills, plates, and tables. A mill run was made at the Boulder property, which is equipped with a 20-stamp mill and vanners. The National Mining & Development Co., formerly a large producer, was practically idle on account of high costs of material and supplies. The Mohawk property produced some lead ore, and the Gem of the Mountains made a few shipments of ore rich in gold and silver and containing also some copper and lead. The placer production was $51,516 in gold and 691 ounces of silver. The largest production of placer gold was a clean-up of the Moore and Elk Creek placers by the Boston & Idaho Dredging Co. Later in the year this large dredge, which had aided materially in the gold production of Idaho, was moved to California. Other gold producers were the Boise Basin Improvement Co. and the Centerville Mining & Milling Co.

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[1] U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 616, 1915.

BONNER COUNTY.

There was a decrease in the value of the output of Bonner County in 1918. Nearly all of the ore came from the Lawrence mine, which produces lead ore. An unusually rich lead concentrate was shipped to Utah. At the Keystone property, operated by the Armstead Mines (Inc.), development of silver ore continued and plans were made for a concentration plant. A test shipment of lead ore was made from the Woodrat mine in the Priest River district.

BONNEVILLE COUNTY.

Mount Pisgah district.—Gold of unusual fineness was mined near Gray by the Idaho Mining & Dredge Co.

BOUNDARY COUNTY.

Two deep mines in Boundary County produced 27,973 tons of ore, containing 77,218 ounces of silver and 4,404,322 pounds of lead, valued in all at $389,925. Most of the ore, 27,824 tons, was concentrated and the remainder, 149 tons, was shipped directly to smelters. The ore was all lead ore, which had a total value per ton of $13.94 and a gold and silver value of $2.76.

Porthill district.—Practically the whole output of the county came from the Idaho Continental property, at Klockmann. This is one of the large lead-producing districts of the State. The mine is equipped with a 250-ton concentration plant and several thousand tons of rich concentrate were marketed. There was also much material on hand which was not put on the market before the price of lead dropped considerably toward the end of the year.

BUTTE COUNTY.

Two deep mines in Butte County produced 1,215 tons of ore valued at $51,776. Eight deep mines in 1917 produced 5,898 tons of ore. The entire product in 1918 was lead ore, which had a total value per ton of $42.61, of which the gold and silver was $7.05.

Antelope district.—Shipments of oxidized lead ore were made from the Lead Bell property.

Dome district.—The Wilbert property, formerly large producer of lead, produced only a few shipments of crude ore and a small quantity of milling ore. The concentration mill was destroyed by fire in October.

CAMAS COUNTY.

Camas County, which was formerly western Blaine County, produced a few tons of lead ore from the Little Smoky district and some gold ore which was treated by amalgamation and concentration at the El Oro property in Skeleton Creek district. The output, however, was much less than in 1917.

CASSIA COUNTY.

A test shipment of lead concentrate, containing considerable gold, was made from the operations of the new mill on the Melcher property, in the Stokes district. A small shipment of oxidized zinc ore was made from the Valley View property, and a test shipment of silver ore was made from the Hazel Pine mine, both in the Black Pine district.

CLEARWATER COUNTY.

Two deep mines and 10 placers produced 37 tons of ore, $4,844 in gold, and 76 ounces of silver. The value of the output was $4,920 in 1918, $17,503 in 1917, and $26,455 in 1916.

Moose Creek district.—There was a small placer production from Moose and Independence creeks, amounting to $516 in gold and 3 ounces of silver.

Pierce district.—Six placers and 2 deep mines produced 37 tons of ore, $4,281 in gold, and 72 ounces of silver. In 1917 the placer output was valued at $17,061. The decrease was due to the idleness of the dredge formerly operated by the Pierce Co. (Ltd.).

CUSTER COUNTY.

Twenty-seven deep mines produced 62,299 tons of ore in 1918, a decrease of 21,404 tons. The production of the county, including the output of 5 placers, was $53,264 in gold, 197,687 ounces of silver, 3,544,998 pounds of copper, and 3,043,018 pounds of lead, in all valued at $1,342,619. The ore had an average value per ton of $21.53, of which the value of the gold and silver was $4.01. Other than Shoshone County, this is the only county in the State that produced metals valued at more than a million dollars. The output of the county in 1917 was valued at $1,740,685. The ore was divided into 54,236 tons of copper ore, 7,955 tons of lead ore, 105 tons of copper-lead ore, and 3 tons of siliceous ore. Most of the product was crude ore shipped to the smelters, 62,221 tons, valued at $1,337,134, or $21.49 a ton. No ore was treated by amalgamation or cyanidation, but a few tons were concentrated.

Alder Creek district.—Seventeen deep mines produced 58,971 tons of ore, containing $51,869 in gold, 92,536 ounces of silver, 3,504,129 pounds of copper, and 1,086,181 pounds of lead, valued in all at $1,087,044, or an average value per ton of $18.43. In 1917 the mines of the district produced 80,886 tons of ore, valued at $1,579,148. With the exception of 28 tons of ore, which was concentrated, the entire output was shipped directly to smelters. The main cause for the decrease was that shipments of copper ore from the Empire Copper property were somewhat reduced at the request of the smelting company. Notwithstanding this fact, the company shipped an average of more than 4,000 tons a month, and remained the largest producer of copper in Idaho. A dividend of $50,000 was paid in July. Another large producer in the district was the Homestake-Copper Queen and Blue Bell group, operated by the United States Mining

Co. These claims produced several thousand tons of oxidized lead ore. Considerable output of lead ore also came from the Horseshoe mine. Smaller shipments were made from the International, Little Johnnie, and Star properties.

Bayhorse district.—Eight deep mines produced 3,325 tons of ore, containing $118 in gold, 104,609 ounces of silver, 40,864 pounds of copper, and 1,956,517 pounds of lead. valued in all at $253,732, or an average value per ton of $76.31. With the exception of a few tons of old tailings shipped the entire tonnage was first-class shipping ore. The largest output came from the Red Bird mine, which produced an oxidized lead ore and some copper carbonate. The Ramshorn mine, formerly a large producer, was again operated and several shipments of copper ore were made from it to the smelters near Salt Lake. Smaller shipments came from the Forest Rose, Compass, Eureka, Hermit, and Rob Roy properties.

Stanley Basin district.—A few ounces of placer gold was mined at the Challis & Sturkey ground and at the Hohman placer.

Yankee Fork district.—Three placers and 2 deep mines produced 3 tons of ore, $579 in gold, 523 ounces of silver, 5 pounds of copper, and 320 pounds of lead, in all valued at $1,126. Both the Montana and Bonanza properties, formerly producers, were idle.

ELMORE COUNTY.

Four deep mines produced 1,270 tons of ore, a decrease of 24,346 tons. The value of the ore increased from $4.18 a ton in 1917 to $7.99 in 1918. The total output of the county, including that of 4 placers, was $9,865 in gold and 1,473 ounces of silver, valued in all at $11,338. The placer output was $1,183 in gold and 12 ounces of silver.

Bear Creek district.—The only production of the district, other than small lots of placer gold, was that of the Vibrator group, near Rocky Bar. An amalgamation mill having a capacity of 15 tons a day was completed in August, and some bullion, containing gold and silver, was marketed in the Eastern States.

Middle Boise district.—Three deep mines and 1 placer produced 1,120 tons of ore, $7,462 in gold, and 1,427 ounces of silver, valued in all at $8,889. This was a decrease from 25,590 tons, valued at $106,755, in 1917, as a result of the idleness of the Boise Rochester property at Atlanta. The Idaho Bonanza placer was operated for about two months and produced a little gold.

Snake River district.—The Edna placer, near King Hill, was operated for a short period and several shipments of unusually fine bullion were made.

FREMONT COUNTY.

Skull Canyon district.—The output of the district consisted of several shipments of oxidized copper ore from the Skull Canyon property, which was idle the greater part of the year. The mines of the district have recently been described in a survey publication.[1]

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[1] Umpleby, J. B., Geology and ore deposits of the Mackay region, Idaho: U. S. Geol. Survey Prof. Paper 97, 1917.

GEM COUNTY.

West View district.—The output of the West View district consisted of one shipment of siliceous silver ore from the Zuli Double Eagle property and a small shipment of sulphide lead ore from the North Basque claim. No mills were active in the district, though it was a considerable producer of gold and silver bullion some years ago.

IDAHO COUNTY.

Mine production in Idaho County, Idaho, in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	
1917	56	11,351	$211,924	5,050	7,132	$218,032
1918	38	15,567	82,059	4,987	....	87,046
Increase or decrease, 1918	....	+4,216	−129,865	−63	−7,132	−130,986

[a] Includes placer production.

Twenty-two deep-mine operators produced 15,567 tons of ore, an increase of 4,216 tons. The value per ton of the output decreased from $18.19 in 1917 to $5.27 per ton in 1918, all of which was for gold and silver. The total output of the county, including that of 16 placers, was valued at $87,046. The placer output was $4,794 in gold and 42 ounces of silver, valued in all at $4,836. Nearly all of the ore, or 15,560 tons, was treated in gold and silver mills and produced bullion valued at $81,572, or $5.24 a ton. The gold resources of this county are worthy of further development, though there is great need of transportation facilities, according to a recent press statement.[1]

Camp Howard district.—A few ounces of placer gold came from the Klondyke property, near Cottonwood.

Elk City district.—Eleven deep mines and 2 placers produced 192 tons of ore, $2,993 in gold, and 45 ounces of silver, valued in all at $3,038. The value of the output in 1917 was $10,068. Shipments of gold bullion came from the Black Pine, Last Chance, and Mineral Zone properties.

Florence district.—A test shipment of concentrate containing silver was made from the Bullion mine.

Marshall Lake district.—Bullion containing gold and silver was produced by the Sherman & Corporal property. The output was much less than in 1917, when the mine held the record of being the largest producer of gold in Idaho.

Newsome district.—Some placer gold was mined by the Moose Creek Gold Mining Co., and for a short period milling of gold ore was carried on by the Mackay Mining Co.

Orogrande district.—The Orogrande Gold Mining Co. operated its cyanide plant for a short time and made several test runs on ore which assayed about $2 a ton in gold. The lack of transportation and the cost of all supplies are serious drawbacks to mining in the district.

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[1] Thomson, F. A., Min. and Sci. Press, Sept. 28, 1918, p. 430.

Tenmile district.—Four deep mines and 2 placers produced 810 tons of ore, $10,763 in gold and 176 ounces of silver, in all valued at $10,939. The ore had a value per ton of $12.86. Bullion was shipped from the New York, Buckhorn, Gold King, and Lone Pine properties. An 18-ton mill was installed at the Lone Pine property during the year, but was not successful in treating the ore. Small placer productions came from the Tippie and Little Leggett properties.

Warren district.—Two deep mines and 4 placers produced 1,907 tons of ore, $21,154 in gold and 351 ounces of silver, in all valued at $21,505. The Idaho Standard Mines Co., was closed in July, as the cost of material and high wages made operations unprofitable. Placer bullion contained $2,149 in gold and 21 ounces of silver.

Unorganized district.—Three placer operators produced gold valued at $765 and 8 ounces of silver, largely the results of hydraulic mining at the Fischer placers on the South Fork of Clearwater River.

LATAH COUNTY.

Hoodoo district.—Several shipments of oxidized copper ore were made from the Mizpah property, operated under lease by the Collinswood Mining Co.

LEMHI COUNTY.

Mine production in Lemhi County, Idaho, in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	42	19,048	$59,610	159,994	211,642	7,282,166	$875,489
1918	39	12,253	40,829	136,871	103,663	5,454,251	590,557
Decrease, 1918	....	6,795	18,781	23,123	107,979	1,827,915	284,932

[a] Includes placer production.

Thirty-two deep mines produced 12,253 tons of ore, a decrease of 6,795 tons. The total value of the ore was $46.77 a ton, and $13.07 for the gold and silver content. Seven placers produced gold valued at $17,297 and 199 ounces of silver, valued in all at $17,496. The placer output in 1917 was valued at $41,530. Two dredges were operated during the year, but the shipments of bullion were less than in 1917. Most of the ore, or 11,164 tons, was shipped directly to the smelters, and had a total value of $561,035, or $50.25 a ton. There were 1,044 tons of ore treated in gold and silver mills, valued at $3,685, and 45 tons were concentrated. The ore was classified as 10,034 tons of lead ore, 1,853 tons of siliceous ore, and 366 tons of copper ore.

Carmen Creek district.—The Drilling Development Co. is reported to have blocked out much ore containing gold, silver, lead, and zinc. A milling plant, which includes a roaster and Koering drums for cyanidation, was being installed late in 1918.

Eldorado district.—Four deep mines and 1 placer produced 219 tons of ore, $178 in gold, 38 ounces of silver, and 30,880 pounds of copper, in all valued at $7,844. Several shipments of sulphide copper ore were made by the Harmony Mines Co. The mine is opened by an adit 800 feet long and 700 feet of drifting was done during 1918. A car of copper ore was also shipped by the Pope Shenon Mining Co. and plans made for a milling plant.

Eureka district.—A fair production of placer gold resulted from the operations of the Mullen dredge on Moose Creek.

Hayden Creek district.—An initial shipment of copper ore was made from the Copper King property.

Indian Creek district.—Some gold ore from the Bryn Mawr property near Ulysses was treated by amalgamation. The Kittie Burton mine was idle.

Junction district.—The Sunset Mining Co. operated the Leadville property and made shipments of sulphide lead ore. In the last part of the year the company installed a 50-ton mill designed for concentration.

Kirtley Creek district.—Several shipments of gold bullion resulted from the dredge operations on Kirtley Creek, but later in the year the dredge was dismantled, as the valuable placer ground was exhausted.

Mackinaw district.—One deep mine and 2 placers produced 35 tons of ore, $2,448 in gold and 15 ounces of silver, in the Mackinaw district. A large part of the gold was the result of sluicing and hydraulicking on the Hockensmith placer.

McDevitt district.—Small shipments of copper concentrate and crude ore were made from the Copper Queen property, operated by the Idaho Seattle Mining Co.

Mineral Hill district.—Four deep mines and 1 placer produced 769 tons of ore, $8,145 in gold, and 74 ounces of silver, in all valued at $8,219. A large part of the output came from the Kentuck property, which is equipped with an amalgamation and concentration plant. Some ore was treated by amalgamation at the old Monolith property, now owned by the Mineral Hill Gold Mining Co., and a small quantity of ore from the Climax mine was treated by amalgamation and concentration, though the concentrates were not sold.

Spring Mountain district.—Three deep mines produced 229 tons of ore, containing $268 in gold, 1,727 ounces of silver, 518 pounds of copper, and 156,788 pounds of lead, in all valued at $13,255, or an average value per ton of $57.88. Shipments consisted of oxidized lead ore from the Winnie, Iron Mask, and Lemhi Union properties.

Texas district.—Ten deep mines produced 9,491 tons of ore, containing $11,579 in gold, 124,815 ounces of silver, 37,807 pounds of copper, and 4,998,416 pounds of lead, valued in all at $500,619, or an average value per ton of $52.75. Eight deep mines produced 13,995 tons of ore in 1917, valued at $707,008. As in former years, most of the product was an oxidized lead ore shipped to smelting plants in Utah. The largest producer was the Latest Out mine, followed by the Pittsburg-Idaho and Gilmore properties. About 400 tons a month were shipped from the Latest Out, and less than 300 tons per month from the Pittsburg-Idaho property. In 1917 operations at the latter mine resulted in a financial loss, but conditions improved after the power plant was installed, and sinking to the 700-foot level was in progress. Other shipments were made from the Brown Bull, Alex Stevens, Mountain Boy, and Tidal Wave properties.

OWYHEE COUNTY.

Mine production in Owyhee County, Idaho, in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	18	871	$12,746	29,088	....	8,407	$37,438
1918	14	2,187	8,742	30,735	907	987	39,771
Increase or decrease, 1918	....	+1,316	−4,004	+1,647	+907	−7,420	+2,333

[a] Includes placer production.

Twelve deep mines in Owyhee County produced 2,187 tons of ore, an increase of 1,316 tons. The ore had a total value per ton of $18.17 and a gold and silver value of $18.03. The entire product was siliceous. The production of gold and silver in the county from the discovery of gold in 1863 to and including that of 1918 was $21,652,346 in gold and 24,410,517 ounces of silver, having a total value of $40,463,602. There were only 2 small placers operated in 1918.

Carson district.—Eleven deep mines produced 237 tons of ore, containing $2,870 in gold and 18,455 ounces of silver, in all valued at $21,325, or an average value per ton of $89.98. Most of the ore, or 199 tons, was milled and produced bullion and concentrates. The larger part of the output came from the old Trade Dollar property, operated by the Florida Mountain Mines Co.

Steele district.—For a short period during the year the Demming Mines Co. operated a 100-ton flotation plant on Boulder Creek. Concentrates containing gold and silver were shipped to Utah. Silver was developed in the Owyhee silver mine and a mill planned for its treatment.

POWER COUNTY.

A small placer production came from the Diamond & Dredge property on Snake River, near Aberdeen.

SHOSHONE COUNTY.

Mine production in Shoshone County, Idaho, in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	66	2,522,127	$85,683	11,241,126	2,876,911	372,007,653	77,724,221	$50,054,297
1918	52	1,918,052	245,450	8,447,219	2,706,535	278,613,238	43,661,314	33,115,903
Increase or decrease, 1918	....	−604,075	+159,767	−2,793,907	−170,376	−93,394,415	−34,062,907	−16,938,394

[a] Includes placer production.

Shoshone County, or the Coeur d'Alene region, continues to be the most important mining center of the State. It comprises several mining districts, the production of each of which is given separately. Forty-seven deep mines in the county produced 1,918,052 tons of ore, a decrease of 604,075 tons from the output of 1917, when 60 deep mines were productive. The total value per ton of the ore as mined was $17.17 and the value per ton in gold and silver was $4.43. The corresponding values in 1917 were $19.84 and $3.70. The value of the county output decreased nearly 34 per cent, but it represented nearly 91 per cent of the total value of the State output. There was a good increase in the production of gold, but a marked decrease in the production of the other metals. The output of lead ore ranked first with 1,359,437 tons, and lead-zinc ore was next with 481,517 tons. There were also 72,744 tons of copper ore and 4,354 tons of zinc ore. More than 80 per cent of the total ore of the State (1,681,647 tons) and 127,298 tons of old tailings were concentrated and reduced to 308,048 tons of concentrates, containing $36,234 in gold, 5,981,414 ounces of silver, 1,722,545 pounds of copper, 215,011,717 pounds of lead, and 40,175,244 pounds of recoverable zinc, in all valued at $25,364,895, or $82.34 a ton. These concentrates were classified as 3,563 tons of copper concentrates, containing 223.80 ounces of gold, 152,441 ounces of silver, and 1,132,480 pounds of copper; 252,562 tons of lead concentrates, containing 1,529.02 ounces of gold, 5,652,921 ounces of silver, 590,065 pounds of copper, and 209,182,868 pounds of lead; 5,772 tons of zinc concentrates, containing 23,152 ounces of silver, 214,800 pounds of lead, and 3,939,550 pounds of recoverable zinc; and 46,151 tons of lead-zinc concentrates, containing 152,900 ounces of silver, 5,614,049 pounds of lead, and 36,235,694 pounds of recoverable zinc. Twenty-eight milling plants, having a combined daily capacity of approximately 9,805 tons, were active during the greater part of the year. These mills were concentration plants, and 21 of them used flotation machines. A bulletin[1] on the treatment of the complex ores of Idaho was recently published by the Bureau of Mines.

Of the county ores treated or shipped, 109,107 tons were first-class crude ore, containing $22,862 in gold, 2,463,758 ounces of silver, 983,990 pounds of copper, 63,601,521 pounds of lead and 3,486,070 pounds of recoverable zinc, in all valued at $7,562,606, or $69.31 per ton. The crude ore smelted included 3,204 tons of copper ore, containing 614.38 ounces of gold, 1,907 ounces of silver, and 525,732 pounds of copper; 101,177 tons of lead ore, containing 486.37 ounces of gold, 2,455,518 ounces of silver, 458,258 pounds of copper, and 63,335,319 pounds of lead; 4,069 tons of zinc ore, containing 2,991 ounces of silver, 177,923 pounds of lead, and 3,180,565 pounds of recoverable zinc; and 657 tons of lead-zinc ore, containing 5.20 ounces of gold, 3,342 ounces of silver, 88,279 pounds of lead, and 305,505 pounds of zinc. Five placer mines in the county produced $186,354 in gold and 2,047 ounces of silver.

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[1] Varley, Thomas, Preliminary report on the mining districts of Idaho: Bur. Mines Bull. 166, 1919.

Some recent articles referring to the region are noted below.

Rice, C. T., Flotation in the Coeur d'Alene: Eng. and Min. Jour., April 20, 1918, p. 707.

——— Use of pulverized coal at the Bunker Hill & Sullivan Smelting & Refining Works: Eng. and Min. Jour., July 20, 1918, p. 91.

——— The blast furnace charge at the Bunker Hill smelter: Eng. and Min. Jour., September 7, 1918, p. 436.

——— Sintering and charge delivery at the Bunker Hill plant: Eng. and Min. Jour., October 12, 1918, p. 436.

——— Lead refinery at Bunker Hill plant: Eng. and Min. Jour., November 2, 1918, p. 771.

——— Differential flotation at Wallace: Eng. and Min. Jour., September 14, 1918, p. 482.

Bell, R. N., Mining industry of Idaho for 1918: Idaho State Mine Inspector Twentieth Ann. Rept., 1919.

Mine production in the Coeur d'Alene region, Shoshone County, Idaho, 1884–1918.

Year.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Fine ounces.	*Pounds.*	*Short tons.*	*Pounds.*	
1917	$85,683	11,241,126	2,876,911	186,004	77,724,221	$50,054,297
1918	245,450	8,447,219	2,706,535	139,307	43,661,314	33,115,903
1884–1918	5,853,849	173,550,981	70,760,964	2,786,684	378,312,755	443,051,232

Since the beginning of mining in 1884 the Coeur d'Alene region has produced gold, silver, copper, lead, and zinc valued at $443,051,232—gold, $5,853,849; silver, $110,871,401; copper, $11,603,976; lead, $276,969,830; and recoverable zinc, $37,752,176. The production of this region by years, from 1884 to 1913, was given in the report for 1913.[1] From 1904 to 1918 the operators in the region mined, shipped, or treated 28,628,607 tons of ore.

Beaver district.—Three deep mines and 3 placers produced 167,841 tons of ore, $413 in gold, 202,213 ounces of silver, 672 pounds of copper, 10,499,637 pounds of lead, and 35,530,442 pounds of zinc, in all valued at $4,181,536. The ore had a value per ton of $24.91. The output of 4 deep mines and 4 placers was valued at $6,128,703 in 1917. Most of the ore, 79,002 tons, together with 84,065 tons of old tailings, was milled and produced 45,435 tons of concentrates. The remainder, 4,774 tons of first-class ore, was shipped to the various smelters. Important shipments of both crude ore and concentrates were made by the Amazon Manhattan Mining Co., which operated the Ray Jefferson mill, equipped for concentration and flotation. The mine is opened to a depth of 1,000 feet. Most of the district output was that of the Consolidated Interstate-Callahan Mining Co., which operated a 600-ton mill throughout the year. For about five months no ore was mined but production came entirely from the retreatment of old tailings in the flotation plant. According to the figures of the assessor, 85,363 tons of ore were extracted. The gross value of the production, with other income, was $1,833,671; cost of extraction, $864,045; freight and treatment, $605,055; betterments and repairs, $92,240; and net profits, $272,331.

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[1] U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 780, 1914.

The following paragraphs are taken from the printed report[1] of the company:

The decrease in the company's earnings as compared with 1917 is due to the enormous decline in the price of spelter, and to the abnormally high cost of all operating expenses. For comparison: in 1916 the spelter market averaged 12.634 cents per pound; in 1917 it averaged 8.813 cents per pound, and in 1918 it averaged 7.89 cents per pound. During 1918 the labor wage scale advanced to $5.25 per day, in comparison with $3.50 per day in normal times. Our decreased earnings were also attributable to the further fact that we were operating for the greater part of the year on a half production basis, while the overhead charges remained the same.

The cost of all supplies entering into mining operations also advanced nearly 100 per cent. The scarcity of labor, brought about by the heavy draft into the United States War service, and the marked decrease in efficiency of labor obtainable, also handicapped us greatly in our mining operations. * * *

Since the fall of 1916 nearly all our zinc product was delivered to the American Metal Co. (Ltd.), under contract, to which we were shipping an average monthly tonnage of 6,000 tons of zinc ore and concentrates at a rate which gave our company a splendid profit up to the time the United States entered the World War. However, with this country at war, the situation became entirely changed. Smelter costs, as well as mining costs, increased very rapidly, and we were soon faced with insistent demands from the Metal Co. for an increase in treatment charges, and a reduction in tonnage shipped. Desiring to be fair to the smelter company under all the changed conditions (and notwithstanding our contract), this company agreed temporarily, from month to month, to reduce its shipments to 50 per cent of the contracted tonnage. We, therefore, in June of 1918, discontinued mining operations in the property and took our entire shipments (reduced to about 3,000 tons per month) from the stockpile which had been accumulated at the mill. However, this concession did not satisfy the Metal Co., which later insisted upon further allowances. Realizing that we could not afford, in the interest of our stockholders, to make any further concessions, the controversy over the ore contract was finally compromised and adjusted by this company canceling the ore contract in consideration of the Metal Co. turning back to it all the stock of this company owned by the Metal Co., which amounted to 145,097 shares of the aggregate par value of $1,450,970. * * *

Since the cancellation of the contract above referred to this company has closed a contract with the Grasselli Chemical Co., of Cleveland, Ohio, which provides a market for its zinc output until July 1, 1919.

At the close of the year covered by this report the company was shipping a greater tonnage of lead-silver ore than ever before in its history, and all indications point to a continued increase in this product. Under a five-year contract made in 1915, our lead-silver ore is going to the Ohio & Colorado Smelting & Refining Company, at Salida, Colo. * * *

During the year the shaft has been sunk an additional 170 feet, making a total depth of 1,100 feet below No. 4 level, the main working tunnel. No. 9 station, which is now our lowest working level, was cut at a point 1,050 feet below No. 4 level, and there is a 50-foot sump below this station. We also cut a waste pocket above the station level to take care of the waste from the shaft while sinking in the future. The sinking hoist will be installed and all sinking operations will be carried on from this level, which will eliminate all interference with our mining operations on the upper levels. A small sinking pump installed in the sump below the station is able to take care of the water that is making in the shaft. * * *

The following development work has been done during the 12-months' period: 5,389 feet on all claims and 20,000 cubic feet removed for station and skip chutes. * * *

The amount of ore delivered to the mill was 84,720 dry tons. From the tonnage taken from the mine to the mill there was 2,757 tons of crude zinc ore assaying 48.3 per cent zinc and 3.46 per cent lead; 1,634 tons of crude lead

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[1] Consolidated Interstate-Callahan Mining Co. Sixth Ann. Rept., for year ending Dec. 31, 1918.

> assaying 54.7 per cent lead and 19.91 ounces silver and 11,462 tons of waste sorted from the belt. The balance, 68,867 dry tons, went through the mill. * * *
>
> We are now mining an average of 525 tons a day, and expect to increase this output, so that we will ship an average of 6,000 tons per month of zinc and lead-silver ores from now on.
>
> During the months of June, July, August, September, and October the work in the mine was confined to development work, no ore being delivered to the mill from the mine, the total shipments coming from the tailings dump during this period.
>
> An estimate of our ore reserves on January 1, 1919, showed a total of approximately 293,000 tons. * * *
>
> During the months of June, July, August, September, and October, there was a total tonnage of 46,802 tons of slime tailings assaying 13.96 per cent zinc and 2.16 per cent lead, and 37,245 tons of tailings assaying 7.5 per cent zinc and 2.4 per cent lead, milled from the stock pile. These tailings were recovered by a Sauerman slack line cable excavator at a very low cost. The flotation concentrates made from these tailings were passed over 10 Deister-Overstrom slime tables and 4 Wilfley tables, and in this way we were able to separate a certain per cent of lead from the zinc.

The milling ore contained 152,654 ounces of silver, 9,288,444 pounds of lead, and 27,101,828 pounds of zinc; the tailings contained 71,993 ounces of silver, 3,548,100 pounds of lead, and 18,541,180 pounds of zinc. The results in concentrates and first-class ore were 202,750 ounces of silver, 12,098,429 pounds of lead, and 39,474,326 pounds of gross zinc in zinc products.

A few shipments of crude lead ore came from the Tuscumbia property, and 3 small placers produced $393 in gold and 4 ounces of silver.

Coeur d'Alene district.—The Yukon Gold Co. operated its dredge on Prichard Creek throughout the year and made the most important gold production of Idaho. According to the printed report[1] the dredge began work December 4, 1917, and treated 1,448,306 cubic yards of material, including that treated in December, 1917. The gravel had a value of 12.97 cents a cubic yard and the cost amounted to 7.3 cents a cubic yard. The statement to the assessor gave 1,387,706 cubic yards of gravel treated in 1918. The gross value was $177,140; cost of extraction, $79,700; freight and treatment, $778; betterment and repairs, $14,700; and net profits, $81,962.

The company report says:

> This dredge proceeded downstream to the limits of the payable area. In turning around to reach its upper stretch of property, the dredge was forced to handle tailings during the months of November and December, which materially reduced its production.

Eagle district.—Several shipments of galena of good grade were made from the Jack Waite property, but the mine was closed during a large part of 1918 on account of the damage done to the railroad by floods.

Evolution district.—Three deep mines produced 1,111 tons of ore, containing $171 in gold, 48,090 ounces of silver, 2,576 pounds of copper, and 225,078 pounds of lead, in all valued at $64,878, or a value per ton of $58.40. In 1917 the value of the output was $205,529. Some ore was milled at the Charles Dickens property and at the Silverado mine. The largest mine of the district is the Yankee Boy property, operated by the Big Creek Leasing Co. The output, which is shipped to East Helena, Mont., is a sulphide lead ore, containing much silver.

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[1] Yukon Gold Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

Hunter district.—Four deep mines produced 476,674 tons of ore, containing $10,291 in gold, 1,461,601 ounces of silver, 1,172,395 pounds of copper, 45,892,391 pounds of lead, and 3,392,559 pounds of recoverable zinc, in all valued at $5,328,556, or a value per ton of $11.18. The output was divided into 437,499 tons milled (and producing 42,873 tons of concentrates), 33,935 tons of crude ore, and 5,240 tons of old tailings. In 1917 the mines produced 585,903 tons of ore, valued at $8,351,948. The largest producer was the Morning mine, owned by the Federal Mining & Smelting Co., which was operated ten and a half months during the year. The decided decrease in the shipments from this property resulted in an output of lead and zinc which was only about half of that in 1917. According to the figures of the assessor, 265,877 tons of ore was extracted, having a gross value of $3,079,144. The cost of extraction was $1,178,501; freight and treatment, $1,061,826; betterments and repairs, $77,446; and net profits, $761,369. The printed annual report[1] of the company referring to the Morning mine and mines in other districts contains the following notes:

> During the year four dividends of 1.75 per cent each, aggregating $839,027, were paid to the holders of the preferred stock.
>
> The amount of ore and concentrates shipped yearly for the last four years is as follows: 1918, 73,961 tons; 1917, 130,097 tons; 1916, 137,390 tons; 1915, 75,449 tons. * * *
>
> *Mace mines.*—These are operated now only by leases.
>
> *Wardner mine.*—This property, pursuant to the terms of our arrangement with the Bunker Hill & Sullivan Mining & Concentrating Co., has been turned over to them.
>
> *Morning mine.*—Developments during the past year are very satisfactory, although not so much work was done in this connection as usual, owing to the shortage of labor.
>
> The suit of the Star Mining Co. against the Federal Co., alluded to in our last annual report, has been appealed to the Circuit Court of Appeals, and was submitted after hearing in February of this year. * * *
>
> The ore reserves of the Morning mine, January 1, 1919, were 1,165,000 tons, an increase of 535,330 tons. The tonnage is equivalent to 76,110 tons of lead concentrates, 102,040 tons of zinc concentrates, and 113,120 tons of crude lead ore. * * *
>
> Ore was mined in Shoshone County during the year as follows: Morning mine, 265,877 tons; Wardner mine, 43,355 tons; Green Hill mine, 852 tons; and leasers, 1,862 tons.

The company also operated the North Star and Independence mines in Blaine County, Idaho; the Lucky O. K. mine in Kansas; and the Brewster mine in Oklahoma.

The Gold Hunter Mining & Smelting Co. operated its mine and 500-ton mill throughout the year, making a production slightly in excess of that of 1917. Shipments of lead concentrate averaged 1,100 tons per month for the year. According to the statement to the assessor, the gross value of the output was $1,028,434; cost of extraction, $667,456; freight and treatment, $290,755; betterments and repairs, $13,693; and net profits, $56,528.

At the National mine the 300-ton mill was operated for a time during the year, treating a low-grade copper ore. This work resulted in the shipment of several thousand tons of concentrate to Tacoma, and made the National property the most important producer of copper in Shoshone County. Improvements were made at the mill, though the plant was not operated at full capacity. In the mine a new hoist and electric pumps were installed and sinking begun below the 1,500-foot level. A recent statement[1] gives interesting data concerning production and costs during the period from November, 1917, to July, 1919. The report says:

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[1] Federal Mining & Smelting Co. Ann. Rept. for year ending Dec. 31, 1918.

> The shaft was unwatered in March, 1917, and deepened from the 1,200 to the 1,500 level. Stations cut and drifts run on the 1,400 and 1,500 levels. The mill repaired at a cost of about $7,500, and milling commenced in November of that year. * * * A winze was sunk from the 1,500 to 1,600, and 227 feet of development done. One raise was driven through the 1,500 and two part way. No ore of commercial grade was encountered below the 1,500 level, as the Snow Storm fault ends the National vein a short distance below this horizon. * * *
>
> As shown by inclosed report, 105,129 tons of ore were milled having a copper content of 1.05 per cent and 3.27 ounces silver, producing 5,931 tons concentrates with a net smelter value of $83 per ton. The mill extracted 74 per cent of the silver and 83 per cent of the copper, milling 17.7 to 1.

The production for the period was 314.12 ounces of gold, 250,639 ounces of silver, and 1,849,560 pounds of copper. The gross value was $652,643, and the net profit $59,080. Mining cost, $2.427 per ton; ore transfer, $0.323; and milling, $1.375.

The North Idaho Metals Corporation treated creek tailings near Mullan and shipped several cars of lead concentrate and lead-zinc concentrate. Development at the Copper King mine disclosed a large body of ore containing silver, copper, and lead.

Lelande district.—Eight deep mines produced 577,743 tons of ore, containing $20,782 in gold, 3,608,178 ounces of silver, 526,126 pounds of copper, 110,923,473 pounds of lead, and 1,284,076 pounds of zinc, in all valued at $11,751,331, or an average value per ton of $20.34. Most of the ore, or 539,681 tons, was reduced to 93,839 tons of concentrates, and 36,797 tons were shipped directly to smelters. In 1917 nine deep mines produced 802,479 tons of ore, valued at $17,051,202. This district was the largest producer of both silver and lead in the State. Most of the production came from the Hecla and Hercules properties, as the mines at Mace, Burke, and Frisco, owned by the Federal Co., were nearly worked out. The Greenhill Cleveland plant was closed in January, 1918, as the profitable ore body was exhausted. Several shipments of concentrates came from milling the ore from the Marsh mine, but operations were entirely suspended in March. The Hercules mine produced the most important output of the district. Crude ore was shipped from Burke and concentrates from the mill at Wallace. According to the statement to the assessor, 76,876 tons of crude ore and concentrate were shipped, having a gross value of $6,193,540. The cost of extraction was $1,776,876; freight and treatment, $2,414,204; betterment and repairs, $86,692; and net profit, $1,915,766. The tonnage compares with 108,052 tons of ore and concentrate shipped in 1917. Dividends paid (but not published) in 1918 were estimated by the Wallace Miner at $2,000,000. Rich ore was mined on three levels below the No. 5 tunnel, and ore resources were greatly improved, though the mine was closed December 25. The crude ore and concentrates shipped from 1901 to 1916 and their contents were given by Weed.[2]

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[1] National Copper Mining Co. (Ltd.), statement July 31, 1919.

[2] Weed, W. H., The Mines Handbook, vol. 13, p. 775, 1918.

The Hecla Mining Co. had a distinctly successful year. The 750-ton mill at Gem was operated continuously, and an additional 600-ton plant near Wallace was leased and operated 8 hours daily. Most of the product, both lead ore and concentrate, was shipped to the Bunker Hill plant at Bradley, Idaho. According to the statement to the assessor, 379,702 tons of ore were extracted, having a gross value of $4,902,611. The cost of extraction was $1,847,555; freight and treatment, $906,550; betterment and repairs, $163,685; and net profit, $1,984,821. The following extracts are taken from the printed report.[1]

> During the year 13,566 feet of development work was accomplished, 3,917 feet of which was on the Ore-Or-No-Go claims.
>
> Shaft sinking to the 2,000-foot level was finished during the year. A station, sump, and skip pocket were cut and a drift toward the ore started, which has not advanced to the point at which we expect to find ore.
>
> On the East ore body some development work was done on all levels between No. 3 adit level and the 900 level. * * *
>
> Work was done on the Ore-Or-No-Go on every level from the highest, No. 2, to the lowest, the 1,200 level.
>
> In the last annual statement it was explained that this ore contained a sufficient amount of zinc to make its extraction necessary and profitable, and only that portion lying above water level could be extracted separately from Hecla ores without adding very extensively to our development and equipment. It has been decided that only that portion of the vein lying above water level will be mined at this time and that future mining in this section will be deferred until the older ore body is exhausted unless the older body should develop a commercial quantity of zinc in the deeper levels. The block of ore just mentioned will be exhausted about the middle of the year at the present rate of production.
>
> Our production for the year shows a slight increase over that of last year. Commencing about the middle of November, because of the falling lead price and the uncertainty regarding the market for metals, our production was reduced to about 75 per cent of normal.
>
> Our ore reserves are estimated as follows: Hecla, 1,180,058 tons; Ore-Or-No-Go, 404,057 tons.
>
> Dividends for the year were $350,000, and total dividends to the end of the period were $7,255,000.
>
> Our income and excess-profit taxes for 1917 are still undetermined and as an adjustment of the question requires the assessment of a tax by the revenue department our taxes for 1918 will be undetermined until basis for taxation for 1917 is determined. * * * The output of both the Hecla and other ground was 379,703 tons. The shipping product was 52,894 tons, containing 51,365,676 pounds of lead, 1,590,062 ounces of silver, and 433,341 pounds of gross zinc.
>
> From the Ore-Or-No-Go section of the property 66,530 tons were milled, making 4,806 tons of concentrate and slimes, containing 204,521 ounces of silver, 5,236,946 pounds of lead, and all of the zinc. The remainder was the output of the original Hecla mine.

Production by the Hecla Co. for 15 years was 387,947 tons of crude ore and concentrate, containing 11,215,076 ounces of silver, 387,152,288 pounds of lead, and 941,229 pounds of gross zinc.

Placer Center district.—Eight deep mines produced 139,975 tons of ore, containing $3,177 in gold, 864,282 ounces of silver, 87,456 pounds of copper, 24,095,147 pounds of lead, and 3,119,663 pounds of recoverable zinc, in all valued at $2,883,706, or a value per ton of $20.60. Of the total tonnage, 8,467 tons were shipped as first-class ore and 128,988 tons were concentrated, making 27,312 tons of concentrates. Seven deep mines in 1917 produced 159,696 tons of ore, valued at $3,340,886. Most of the ouput consisted of crude lead ore and concentrate from the Tamarack & Custer property, now the most important producer of the district. A 400-ton mill equipped for concentration and flotation was operated during the greater part of the year and the product shipped to the plant of the Northport Smelting & Refining Co., at Northport, Wash. According to the figures of the assessor, there were 29,298 tons of crude ore and concentrate shipped from this property, having a gross value of $2,211,457. The cost of extraction was $750,079; freight and treatment, $737,609; betterment and repairs, $26,899; and net profits, $696,870. The company distributed $266,439 in dividends and considerably increased the ore reserves.

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[1] Hecla Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

The Success Mining Co. operated its mine and mill for about seven months of the year. There was therefore a decided decrease in the production of both lead and zinc. Under the existing contract, the price received for zinc concentrate shipped to eastern points was not sufficient to make the operation of the mine profitable. Work ceased in April, but in August the mine was unwatered and the mill run for eight hours a day.

The Rex mine, under the Sheridan lease, produced more than 1,000 tons of lead ore and a few shipments of lead-zinc ore. Creek tailings were treated by the Spokane Metal Recovery Co., but the milling plant was burned in the latter part of the year. Similar material was treated at the Davey plant.

St. Joe district.—Several thousand tons of oxidized copper ore were shipped from the Richmond mine, which is one of the important producers of copper in the State. No shipments were made during the first half of the year and the output was, therefore, curtailed more than 50 per cent. One dividend of $8,400 was paid in October. The income for the year[1] was $92,768, and the expenses, which included $49,893 for labor and $18,075 for supplies, were $84,398, leaving a net profit of $8,370. The report continues:

> A raise was driven from the main tunnel level to the 150 level, a distance of 225 feet. The raise is 11 feet by 4 and is divided into waste chute, ore chute, and manway. The 150 level was driven westerly 130 feet on the vein. A new level called the 200 (but actually 65 feet lower than the 150) was opened up for a distance of 740 feet along the vein. * * * The total drifting and crosscutting for the year amounted to 1,220 feet. The total number of feet in raises amounted to 465 feet and the total development for the year is 1,685 feet. * * *
>
> Only 380 tons were shipped in the first six months of the year 1918 owing to a wreck on the tramway which occurred on January 13, and could not be repaired until April on account of the depth of snow. In May so much water came into the ore chutes that it was impossible to take ore out through them. The total shipments for the year amounted to 3,912 tons, wet weight, carrying an average of 8.4 per cent copper, 0.189 ounce of gold, and 0.64 ounce of silver to the ton, having an average net value of $23 per ton, after deducting freight and smelter charges. * * *
>
> In conclusion it may be well to point out that while copper brought a good price through the year, the price of labor and supplies were so high as to very largely offset the price of copper. . Smelting charges in direct and indirect ways were also advanced from two to three dollars per ton. Freight charges were advanced amounting to 75 cents per ton.

The Montana-Idaho Copper Co. continued development in the long adit. The Monitor vein was cut 3,865 feet from the portal.

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[1] Richmond Mining, Milling & Reduction Co., Ann. Rept. for year ending Dec. 31, 1918.

Summit district.—Three deep mines and 1 placer produced 167 tons of ore, $48 in gold, 719 ounces of silver and 123,382 pounds of lead, valued in all at $9,527. In 1917 the value of the output was $49,595. Small productions came from the Monarch and Bear Top mines, but for a time shipments from the district were prevented by a washout on the Murray branch of the Oregon-Washington Railroad & Navigation Co.

Yreka district.—Sixteen mines produced 551,128 tons of ore, containing $11,891 in gold, 2,257,466 ounces of silver, 391,578 pounds of copper, 86,697,083 pounds of lead, and 334,574 pounds of zinc, valued in all at $8,552,016, or an average value per ton of $15.52. The tonnage was divided into 495,953 tons of ore concentrated, 20,967 tons of first-class ore, and 34,208 tons of old tailings milled. Eighteen deep mines in 1917 produced 807,450 tons of ore, valued at $14,503,653. The Bunker Hill & Sullivan Mining & Concentrating Co. operated its mine and mills throughout the year and produced more lead than any other mine in the State. Half of the product is treated at the Bunker Hill smelter, at Bradley, and the remainder is shipped to the smelters owned by the American Smelting & Refining Co. According to the assessor, 389,027 tons of ore were extracted, having a gross value of $6,094,285. Cost of extraction was $1,410,123; freight and treatment, $2,144,408; betterment and repairs, $821,504; and net profits, $1,379,319. Dividends for 1918 amounted to $1,553,250, and dividends to date to $22,086,750. Extracts from the annual report[1] follow:

> For 1918 the output was lower than for any of the recent years, each of which has regularly shown an increased production of ore. This decrease was due solely to shortage of labor, particularly during the last six months of the year; but at this date the ore production is restored to normal. The labor shortage noted was common to all industries. Many of our workmen were lured away by the higher wages paid by war industries, and 264 of our employees, nearly 25 per cent of our entire force and including many of our best men from all departments, left their employment to enter the war service. Fourteen of these men have given their lives—seven having fallen on the fields of France; and Sergt. Waltman, of the mine crew, who is now on the Rhine, has received the Distinguished Service Cross. In addition there were difficulties of securing mining material of all kinds, even though the cost exceeded all former prices. During this period, however, operations in all departments proceeded with unbroken continuity and reasonable efficiency.
>
> The physical condition of the properties was fully maintained, as development work in the mine was continued, with results indicating a greater tonnage of ore ready for mining than ever before estimated. Development work on the No. 15, or bottom level of the mine, has been particularly successful. * * * So that while our production has suffered during the year because of war conditions, the internal state of the property has been maintained at past standards. * * *
>
> Our experimental metallurgical investigations under way at the North Mill have been conducted with reasonable success, and we are now working on a small commercial scale in the production of copper, which metal is contained in considerable quantities in matter from the smelter.
>
> We have 4,362,024 tons of ore blocked out to date. * * *
>
> The mine was in operation for the full period of 12 months and produced 389,027 tons of concentrating ore at a cost of $1,136,698.89. * * *
>
> Seventeen hundred and forty feet of drifts, crosscuts, and stations were driven at a cost of $23,906.74. * * *
>
> The concentrators were in operation for the full year, and the average work was 1,066 tons per day at a cost of $276,900. * * *
>
> The company shipped 85,165.39 tons of concentrates, at a cost of $26,465.

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[1] Bunker Hill & Sullivan Mining & Concentrating Co. Thirty-first Ann. Rept., for year ending Dec. 31, 1918.

The ore milled, 389,027 tons, assayed 10.22 per cent of lead and 3.87 ounces of silver. From this ore, 84,169 tons of concentrates and middlings were produced, containing 67,125,717 pounds of lead and 1,191,907 ounces of silver. The loss in tailings was 15.61 per cent of the lead and 20.93 per cent of the silver in ore milled, or a total of 16.54 per cent. The total cost per pound of lead was 5.34 cents. From 1886 to 1918 the company has mined 8,275,913 tons of ore having a gross value of $86,341,658. Net smelter returns were $50,925,287, and operating profit was $28,771,132.

The Bunker Hill smelter and refinery were active during the year. In August, two furnaces were in blast and the plant was said to be producing 120 tons of pig lead per day, as well as other products. References to articles on this plant have been previously given. The press[1] gives the following notes on the improvements.

> The Bunker Hill & Sullivan smelter is being enlarged. The furnace building is being extended 72 feet, to allow erection of two blast furnaces. Three Dwight-Lloyd sintering machines have been erected recently, and two more are to be put up, making nine in all. The blower house has recently been doubled in size, and a Connersville blower of 15,000 cubic feet capacity installed in the extension. A new compresser room has been completed and a Sullivan two-stage machine of 1,100 cubic feet capacity erected. In the blower house a Laidlaw-Dunn-Gordon compressor is being installed, to be used as an auxiliary. According to W. K. Mallette, constructing engineer, the most important construction during the last month is the extension to the lead refinery. This is being enlarged by the addition of 72 feet on the west side of the original refinery. The retorts were removed from the silver refinery and are temporarily in the lead refinery. A new softening furnace has been built west of the original No. 2 softener, and two additional desilverizing kettles are to be added. Two new cupelling furnaces have been built in the silver refinery in the space formerly occupied by the retorts. These cupels are much larger than the original double furnace, and have added materially to the capacity of this department. In the furnace building a second traveling crane is to be erected, so that one may be used for the refinery.

The Caledonia Mining Co. shipped crude lead ore at the rate of about 1,500 tons a month. According to the county assessor, 17,971 tons of ore were extracted, having a gross value of $1,096,776. The cost of extraction was $160,879; freight and treatment, $288,078; and net profits, $647,819. According to the printed report,[2] the company paid dividends during the year amounting to $937,800, partly from surplus. The production from 17,971 tons of ore was 668,785 ounces of silver, 94,326 pounds of copper, and 6,038,560 pounds of lead, a large decrease from the totals of 1917.

> Since my statement to you of November 5, 1918, there has been no new ore discovered in the mine, but a substantial output has been maintained and it is probable, if the metal market gets no worse, that earnings for the current year will enable a continuance of the present dividend rate of one cent per share per month, at least throughout the remainder of the year.

The Last Chance mine, owned by the Federal Mining & Smelting Co., was operated during the first half of the year, when it was turned over to the Bunker Hill & Sullivan Co. according to agreement. The statement to the assessor gave 43,355 tons of ore extracted, having a gross value of $222,104. The cost of extraction was $129,626; freight and treatment, $65,773; and net profit, $26,705. The mill at Sweeney has been remodeled to treat the large quantity of old tailings near by, as well as custom ore from lessees in the district.

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[1] Min. and Sci. Press, Dec. 14, 1918, p. 806.
[2] Caledonia Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

A considerable production of lead concentrate came from the ore of the Sierra Nevada mine, which was treated in the mill leased from the Bunker Hill Co. According to the figures of the assessor, the company extracted 19,274 tons of ore, having a gross value of $367,441. The cost of extraction was $76,801; freight and treatment, $103,589; and net profits, $187,050. The ore now developed is sufficient to continue production for two years, according to the statement of the management.

Several thousand tons of lead ore were milled at the Hypotheek property, and rich concentrates were shipped to Colorado and Utah, but the mine was in financial difficulties at the end of the year.

A large quantity of tailings was treated by the Hayes Co. and by the Mullan Milling Co., both of which operated flotation plants. The mine and mill at the Alhambra property were operated about one-third of the year, and lead concentrate was made at the 50-ton plant equipped for flotation. Crude ore of good grade was shipped by the Big Creek Mining Co. The mine, opened by a lower adit 2,350 feet long, produces both galena and gray copper rich in silver. Other producers in the district were the Crown Point, Constitution, Douglas, Nabob, Stewart, and Wyoming properties. Mining in Pine Creek suffered on account of the delay in finishing the railroad to this part of the district, and the Anaconda Copper Co. relinquished the lease on the Douglas mine, an important producer of lead-zinc ore in 1917. Lead-zinc ore of good grade was opened on the 900-foot level of the Nabob Consolidated property, and a concentration plant was planned. The Highland Surprise mine, a large producer in former years, was idle.

TWIN FALLS COUNTY.

Three small placers in Twin Falls County produced $303 in gold and 3 ounces of silver from the sands of Snake River.

VALLEY COUNTY.

Placer operations at the Dewey mine, in the Thunder Mountain district, yielded a fair production of gold bullion. In the Big Creek district a slight production of bullion was made at the Snow Shoe mine, and at Profile a test shipment of silver concentrates made from the Red Metal mine.

WASHINGTON COUNTY.

In the Heath district, the Galena Silver mine was not operated on account of labor conditions, but a shipment of lead ore was made in the early part of 1918. Several shipments of copper ore, containing much silver, were smelted from the Enterprise mine, in Washington district.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN WASHINGTON.[1]

(MINES REPORT.)

By C. N. Gerry.

PRODUCTION.

GENERAL STATEMENT.

The value of the mine production of gold, silver, copper, lead, and zinc in Washington in 1918 was $1,467,421, a decrease of nearly 36 per cent from that of 1917. There was a slight increase in the production of silver, but a decided decrease in the production of the other metals, as well as in the quality of the ore mined. The number of producing properties fell from 136 in 1917 to 84 in 1918. Only one company paid dividends in 1918—which amounted to $87,312, according to the printed report of the Electric Point Mining Co. During 59 years the State has produced gold, silver, copper, lead, and zinc valued at $37,954,087, of which more than 73 per cent was for gold.

Mine production of gold, silver, copper, lead, and zinc in Washington in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	136	172,119	$492,324	282,320	2,199,518	9,789,687	1,195,567	$2,289,285
1918	84	138,911	304,658	310,093	1,922,406	5,271,815	38,873	1,467,421
Increase or decrease, 1918	....	−33,208	−187,666	+27,773	−277,112	−4,517,872	−1,156,694	−821,864
Total, 1860-1918	....	....	27,753,350	7,363,533	12,845,206	32,528,919	3,193,670	37,954,087

ORE.

The quantity of ore sold or treated decreased from 172,119 tons in 1917 to 138,911 tons in 1918, or more than 19 per cent. There was a moderate increase in the output from Snohomish and Okanogan counties, but a marked decrease in that of Pend Oreille, Ferry, Whatcom, and Stevens counties. The total value per ton of the ore decreased from $13.27 in 1917 to $10.54 in 1918, but the value per ton in gold and silver increased from $4.40 from $4.18 to $4.40. Of the total output of ore, nearly 34 per cent was dry or siliceous ore, more than 60 per cent copper ore, and nearly 6 per cent lead ore. No important shipments of zinc ore or lead-zinc ore were made. The siliceous ore averaged per ton $9.51 in gold and silver; the copper ore $1.91; and the lead ore, 42 cents. The siliceous ore was composed of 45,434 tons of gold ore, averaging per ton $6.39 in gold, 2.27 ounces of silver, and 0.15 pound of copper; and 1,717 tons of silver ore, averaging per ton 44 cents in gold, 31.13 ounces of silver, 4.56 pounds of copper, and 13.45 pounds of lead. The gold ore includes 1,449 tons of sulphide iron ore, containing 27.86 ounces of gold and 86 ounces of silver. This class of ore amounted to 4,966 tons in 1917. The siliceous ore, with the iron ore, averaged per ton $6.18 in gold, 3.32 ounces of silver, and a trace of copper and lead. Copper ore as mined averaged 11 cents in gold and 1.79 ounces of silver per ton, and 1.14 per cent of copper, or a total value of $7.54. Lead ore averaged 0.42 ounce of silver per ton and 32.30 per cent of lead, or a total value of $46.30. Zinc ore, all of which was of shipping grade, contained 37.38 per cent of recoverable zinc, or a value of $68.02 per ton. Nearly all of the lead ore and most of the siliceous ore was shipped without treatment, but most of the copper ore was concentrated.

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[1] The statistical tables in this report were compiled by Bessie N. Patchell, of the United States Geological Survey.

Ore and metals produced in Washington in 1918.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placer	10		165.93	45			
Dry or siliceous	37	47,151	14,107.36	156,772	14,448	23,095	
Copper ore	23	83,583	463.82	149,858	1,907,565		
Lead ore	14	8,125	.72	3,418	393	5,248,720	
Zinc ore	1	52					38,873
		138,911	14,737.83	310,093	1,922,406	5,271,815	38,873

Ore sold or treated from Washington in 1918, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Total.
Chelan	1				1
Ferry	44,223	3,292			47,515
King	170				170
Lewis		24			24
Okanogan	606	2,984	2		3,592
Pend Oreille			221	52	273
Snohomish		12,148			12,148
Stevens	1,195	65,135	7,902		74,232
Whatcom	956				956
	[a]47,151	83,583	8,125	52	138,911
Average value per ton in gold and silver	$9.51	$1.91	$0.42		$4.40

[a] Includes 45,434 tons of gold ore and 1,717 tons of silver ore.

Four milling plants were active in 1918, of which 1 used amalgamation and 3 used concentration with flotation machines. The most important milling operation was that of the United Copper plant, at Chewelah. A new mill in the Index district of Snohomish County was operated on copper ore. No milling was done at Republic, and the Boundary Red Mountain mine in Whatcom County, formerly a large producer of gold, was idle most of the year.

Ore from Washington was treated at 6 smelting plants, 2 of which are within the State and 4 are in British Columbia. A large part of the ore was formerly shipped north to Grand Forks, Greenwood, or Trail, British Columbia, as many of the producing mines are in the eastern part of the State, more than 200 miles from Tacoma. During 1918, however, the Canadian plants suffered from many difficulties, including high costs, shortage of coke, labor strikes, and fire. As a result, copper ore and siliceous ore were shipped to Tacoma, and some lead ore to plants in Utah.

Gold and silver mills treated less than 1 per cent of the total quantity of ore, or 1,022 tons, in 1918, against 10,986 tons in 1917. Most of the ore treated came from Whatcom County, near Sumas. No cyanide was consumed, and only 20 pounds of mercury was used in milling plants. The average consumption of mercury was 0.021 pound per ton of ore amalgamated and 0.038 pound per ounce of gold and silver bulion saved.

Gold and silver produced at mills in Washington in 1918.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Ferry	62			80.72	183	$1,852
Okanogan	4	2.48	2			53
Whatcom	956	483.12	39			10,026
	1,022	485.60	41	80.72	183	11,931

Nearly 53 per cent of the output of ore, or 72,951 tons, was concentrated, a small decrease from 73,673 tons in 1917. Concentrates decreased from 6,076 tons to 4,234 tons. The greater part was a copper concentrate from the Chewelah district, in Stevens County, and the Index district, in Snohomish County, with a small quantity of lead concentrates from the Metaline district, in Pend Oreille County. Copper concentrates averaged $1.69 in gold and 24.93 ounces of silver per ton and 13.26 per cent of copper and had an average value per ton of $92.13. Lead concentrates averaged 27 cents in gold and 31.04 ounces of silver per ton and 0.25 per cent of copper and 41.50 per cent of lead and had a value per ton of $91.50.

Mine production of metals from Washington concentrates in 1918.[a]

County.	Ore to concentrating mills.	Concentrates.	Gold.	Silver.	Copper.	Lead.	Total value of concentrates.
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
Pend Oreille	20	4		7		5,521	$399
Snohomish	10,020	669	48.14	2,937	299,913		78,011
Stevens	62,911	3,561	295.61	102,916	810,589	34,324	311,679
	72,951	4,234	343.75	105,860	1,110,502	39,845	390,089

[a] The concentrates from Pend Oreille County were lead concentrates in 1918, those from Snohomish County were all classified as copper cencontrates, and those from Stevens County were mostly copper except one shipment of lead concentrates.

Nearly 47 per cent of the ore, or 64,938 tons, was mined and shipped directly to smelters. The greatest quantity of ore came from Ferry County, but a more valuable product came from Stevens County. Of the first-class or shipping ore, 71 per cent was dry or siliceous, nearly 17 per cent was copper ore, and nearly 12 per cent was lead ore. The siliceous ore shipped to smelters averaged per ton $6.07 in gold, 3.39 ounces of silver, 0.32 pound of copper, and 0.5 pound of lead, and was valued at $9.57. Copper ore shipped averaged 23 cents in gold and 4.13 ounces of silver per ton, and 3.62 per cent of copper, and was valued at $22.26 per ton. First-class lead ore shipped had an average assay of 0.25 ounce of silver per ton, and 33.59 per cent of lead, and was valued at $47.95 per ton. Crude zinc ore shipped averaged 37.38 per cent of recoverable zinc, and had a value of $68.02 per ton. Most of the copper ore shipped, or 10,988 tons, was sulphide, and contained 120.67 ounces of gold, 45,488 ounces of silver, and 795,899 pounds of copper. The sulphide lead ore shipped was 1,118 tons and contained 0.14 ounce of gold, 968 ounces of silver, 149 pounds of copper, and 1,452,529 pounds of lead. The small output of zinc ore shipped was sulphide. The oxidized copper ore (16 tons) averaged 4.40 per cent of copper, and the oxidized or carbonate lead ore (6,635 tons) averaged 28.31 per cent of lead.

Mine production of metals from Washington crude ore shipped to smelters in 1918.

By counties.

County.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Chelan	1		151				$151
Ferry	47,453	13,273.97	101,193	127,813			407,160
King	170	226.10	2,314				6,988
Lewis	24			2,014			497
Okanogan	3,588	60.60	32,106	169,899	785		75,380
Pend Oreille	253	.15	387	149	188,357	38,873	17,337
Snohomish	2,128		2,060	152,130			39,636
Stevens	11,321	101.02	65,753	359,899	5,042,828		514,777
	64,938	13,661.84	203,964	811,904	5,231,970	38,873	1,061,926

By kinds of ore.

Dry or siliceous	46,129	13,541.03	156,548	14,448	23,095		$441,674
Copper	11,004	120.67	45,488	797,307			244,917
Lead	7,753	.14	1,928	149	5,208,875		371,798
Zinc	52					38,873	3,537

GOLD.

The mine production of gold in Washington was valued at $304,658, against $492,324 in 1917, a decrease of more than 38 per cent. Of this total, nearly 93 per cent came from ores shipped directly to smelters, nearly 4 per cent came from ores treated by amalgamation or cyanidation, more than 1 per cent was from placers, and more than 2 per cent was from concentrates. The table below shows that siliceous ore supplied most of the gold, or nearly 96 per cent, and that copper ore contained only 3 per cent of the total. There was a decrease of more than 9,000 ounces in gold recovered from siliceous ores. Most of the gold was produced by four mines at Republic—the Last Chance, Surprise-Lone Pine-Pearl, Knob Hill, and San Poil. In 1917 the largest gold output was that of the Boundary Red Mountain mine, in Whatcom County, followed by the Republic mines.

Mine production of gold in Washington in 1918, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Total.
Clallam	11.56				11.56
Ferry		13,293.14	61.55		13,354.69
King		226.10			226.10
Kittitas	127.47				127.47
Okanogan	13.64	58.96	4.12		76.72
Pend Oreille				0.15	.15
Snohomish	13.26		48.13		61.39
Stevens		46.04	350.02	.57	396.63
Whatcom		483.12			483.12
	165.93	[a]14,107.36	463.82	.72	14,737.83

[a] Includes 14,070.56 ounces from gold ore and 36.80 ounces from silver ore.

SILVER.

The mine production of silver increased from 282,320 ounces, valued at $232,632, in 1917 to 310,093 ounces, valued at $310,093, in in 1918, an increase of nearly 10 per cent in quantity and $77,461 in value. Stevens and Ferry counties had the largest production. Crude ore shipped to smelters supplied nearly 66 per cent of the total silver, concentrates about 34 per cent, and placers and mill bullion less than 1 per cent. Siliceous ore contained more than 50 per cent of the silver, copper ore more than 48 per cent, and lead ore 1 per cent. The following five mines produced 80 per cent of the total silver of Washington: United Copper, Last Chance, Surprise-Lone Pine-Pearl, Deer Trail, and Knob Hill.

Mine production of silver in Washington in 1918, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Total.
Chelan		151			151
Clallam	2				2
Ferry		100,902	474		101,376
King		2,314			2,314
Kittitas	38				38
Okanogan	2	30,412	1,636	60	32,110
Pend Oreille				394	394
Snohomish	3		4,997		5,000
Stevens		22,954	142,751	2,964	168,669
Whatcom		39			39
	45	[a] 156,772	149,858	3,418	310,093

[a] Includes 103,322 ounces from gold ore and 53,450 ounces from silver ore.

COPPER.

The mine production of copper decreased nearly 13 per cent, from 2,199,518 pounds, valued at $600,468, in 1917 to 1,922,406 pounds, valued at $474,834, in 1918. The production increased slightly in Snohomish and Okanogan counties, but decreased considerably in Stevens and Ferry counties. Crude ore produced more than 42 per cent of the copper and concentrates nearly 58 per cent. Most of the metal came from copper ore, and six mines produced nearly 90 per cent of the total. In order of their importance they were the United Copper, Sunset, Copper World Extension, Lone Star, Turk, and Loon Lake mines.

Mine production of copper in Washington in 1918, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Total.
Ferry	6,620	121,193		127,813
Lewis		2,014		2,014
Okanogan	7,137	162,762		169,899
Pend Oreille			149	149
Snohomish		452,043		452,043
Stevens	691	1,169,553	244	1,170,488
	[a] 14,448	1,907,565	393	1,922,406

[a] Includes 6,620 pounds from gold ore and 7,828 pounds from silver ore.

LEAD.

The mine production of lead in 1918 decreased more than 46 per cent, from 9,789,687 pounds, valued at $841,913, in 1917 to 5,271,815 pounds, valued at $374,299, in 1918. Most of the lead came from the Northport district, of Stevens County, and less than 1 per cent of it came from concentrates. Of the crude lead ore shipped to smelters 6,635 tons were carbonate containing 3,756,346 pounds of lead and 1,118 tons were sulphide containing 1,452,529 pounds of lead. Aside from the Electric Point mine, there were no properties producing large quantities of lead ore.

ZINC.

The mine production of recoverable zinc was 38,873 pounds, valued at $3,537, against 1,195,567 pounds, valued at $121,948, in 1917. In the Metaline district financial difficulties hampered production, and in the Northport region the carbonate ores were exhausted.

MINING INDUSTRY.

Mining in Washington, as in other States, was carried on under unusual difficulties during 1918. The cost of material and supplies, already high in 1917, reached a higher mark in 1918, and freight rates, as well as smelting charges, were increased to a marked degree. There was a decided shortage of labor, partly due to ship building in the West; wages were high, and in the latter part of the year work was seriously affected by the epidemic of influenza. Added to all these factors, which naturally discouraged mining and development work, the average prices of copper, lead, and zinc were less than in 1917, and when in November hostilities ceased there was a decided decrease in metal prices. As a result, the value of the metal output of Washington was reduced to about two-thirds of that of 1917. An interesting publication[1] dealing with the mining conditions in Washington was recently published by the University of Washington. It gives the history, development, and mineral resources of the State and a good bibliography of articles on the various districts. The author has the following to say regarding the future of mining in Washington:

> Notwithstanding all the causes which have hampered mining development in this State, Washington has a future as a mineral producer. On account of the small ore bodies which are typical of the State as a whole, we shall probably never witness large scale development such as characterizes mining in certain other States, but it is possible that careful work on a proper scale in many of the now abandoned mines and prospects of the various districts would be productive of successful results. Similarly conservative development should be applied also to newly discovered deposits.
>
> Improvements in transportation facilities, the building of new railroads and trunk highways over hitherto inaccessible portions of the mountains of the State, the abundant water power which can be used for mine operations and for subsequent ore treatment, the possibilities which this water power affords for the electric smelting of suitable ores of a district without transportation to large plants, the abundance of timber for mine use—all these things favor a successful prosecution of mining. It is not too much to hope that the combination of these favorable factors will ultimately overcome those which are adverse to successful development.

Mine production of gold, silver, copper, lead, and zinc in Washington in 1918.

County.	Ore.	Gold.		Silver.	
		Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ounces.*		*Fine ounces.*	
Chelan	1			151	$151
Clallam		11.56	$239	2	2
Ferry	47,515	13,354.69	276,066	101,376	101,376
King	170	226.10	4,674	2,314	2,314
Kittitas		127.47	2,635	38	38
Lewis	24				
Okanogan	3,592	76.72	1,586	32,110	32,110
Pend Oreille	273	.15	3	394	394
Snohomish	12,148	61.39	1,269	5,000	5,000
Stevens	74,232	396.63	8,199	168,669	168,669
Whatcom	956	483.12	9,987	39	39
	138,911	14,737.83	304,658	310,093	310,093

County.	Copper.		Lead.		Recoverable zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Chelan							$151
Clallam							241
Ferry	127,813	$31,570					409,012
King							6,988
Kittitas							2,673
Lewis	2,014	497					497
Okanogan	169,899	41,965	785	$56			75,717
Pend Oreille	149	37	193,878	13,765	38,873	$3,537	17,736
Snohomish	452,043	111,655					117,924
Stevens	1,170,488	289,110	5,077,152	360,478			826,456
Whatcom							10,026
	1,922,406	474,834	5,271,815	374,299	38,873	3,537	1,467,421

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[1] Fischer, A. H., A summary of mining in the State of Washington: Washington Univ. Eng. Exper. Sta. Bull. 4, November, 1918.

Ore sold or treated, deep mines producing, and average value of ores in Washington in 1917 and 1918.

County.	Ore sold or treated, 1918.		Number of deep mines producing.		Average total value per ton.[a]		Average value per on in gold and silver.[a]	
	Quantity.	Increase or decrease.	1917	1918	1917	1918	1917	1918
	Short tons.	*Short tons.*						
Chelan	1	−20	4	1	$28.71	$151.00	$28.71	$151.00
Ferry	47,515	−11,616	20	16	8.25	8.61	6.98	7.94
King	170	−10	1	1	51.67	41.11	44.29	41.11
Kittitas		−49	6		26.47		4.18	
Lewis	24	+24		1		20.71		
Okanogan	3,592	+1,767	25	18	22.54	21.02	9.93	9.30
Pend Oreille	273	−14,823	7	5	8.80	64.97	.09	1.45
Pierce		−18	1		48.94		2.17	
Skagit		−14	2		30.78		30.78	
Snohomish	12,148	+9,310	7	7	17.89	9.68	.48	.49
Stevens	74,232	−7,811	39	23	17.29	11.13	1.66	2.38
Whatcom	956	−9,941	5	2	12.80	10.49	12.80	10.49
Yakima		−7	2		66.86		8.86	
	138,911	−33,208	119	74	13.27	10.54	4.18	4.40

[a] Placer product excluded.

There were 10 active placer mines, of which 8 were worked by hydraulic and sluicing methods and 2 by drifting. Of the 74 deep mines, 28 produced gold and silver; 4, copper; 24, gold, silver, and copper; 3, silver; 3, gold, silver, copper, and lead; 11, silver and lead; 1, silver, lead, and zinc.

REVIEW BY COUNTIES.

CHELAN COUNTY.

Chelan district.—A test shipment of silver ore was made from the Sunday Morning mine.

CLALLAM COUNTY.

Placer gold valued at $239, with 2 ounces of silver, was produced near Ozette.

FERRY COUNTY.

Mine production in Ferry County, Wash., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	20	59,131	$332,071	98,080	273,624	1,395	$487,708
1918	16	47,515	276,066	101,376	127,813		409,012
Increase or decrease, 1918		−11,616	−56,005	+3,296	−145,811	−1,395	−78,696

There was a decided decrease in the quantity of ore mined and the value of metals produced in Ferry County in 1918. Sixteen deep-mine operators produced 47,515 tons of ore, a decrease of 11,616 tons from 1917. The value of the ore increased from $8.25 to $8.61 a ton. Only 62 tons were treated in gold and silver mills, and the remainder, 47,453 tons, having a value of $407,160, or $8.58 a ton, was shipped directly to smelters. Of the total output, 44,223 tons were siliceous ore and 3,292 tons were copper ore. Ferry County produced nearly 91 per cent of the gold of the State, nearly 33 per cent of the silver, and nearly 7 per cent of the copper.

Belcher district.—Shipments of iron ore were made from the Belcher property, and a few shipments of sulphide copper ore came from the Laurier property. A gravity tramway 2,900 feet long was constructed at the Laurier mine in 1918.

Danville district.—Three deep mines produced 3,576 tons of ore, containing $6,295 in gold, 500 ounces of silver, and 118,106 pounds of copper, valued in all at $35,967, or an average value per ton of $10.06. The output of the district was 18,436 tons in 1916 and 7,337 tons in 1917. Gold ore, containing a little silver and copper, was shipped from the Virginia mine, and the Lone Star & Washington property produced a low-grade copper ore.

Enterprise (*Covada*) *district.*—No shipments were made from the Enterprise district in 1918. The mineral deposits, both of this region and of the Keller or Sanpoil district, have been described in a recent publication.[1]

Republic district.—Eleven deep mines produced 42,275 tons of ore, containing gold valued at $269,195 and 100,574 ounces of silver, both valued at $369,769, or an average value per ton of $8.75. Eleven deep mines in 1917 produced 46,785 tons of ore, valued at $383,379. The entire output of ore, with the exception of 62 tons milled, was shipped directly to smelters to be used primarily for its silica. Substantial development work was preformed on the large producing mines, several of which are owned by smelting companies. From 1896 to the end of 1918 Republic district produced 511,318 tons of ore, containing $6,690,881 in gold and 1,976,318 ounces of silver, valued together at $7,853,435. In former years the Surprise-Lone Pine-Pearl property was the largest producer. So far as quantity was concerned, it remained so in 1918, but the Last Chance mine shipped a better grade of ore and produced more gold. The mine is opened to a depth of 690 feet and drifting was continued on the 500-foot level. Shipments increased to more than 1,000 tons per month during the summer. The properties of this district, and particularly those having low-grade ores, were affected by the increase in freight rates, which amounted to 80 cents a ton for the grade of ore shipped from the Last Chance property. The Knob Hill Mining Co. made shipments, which amounted to nearly 5,000 tons, and improved the equipment and method of handling the ore. The San Poil produced more than 2,000 tons of ore, a small output when compared with the totals of former years. In June work was begun on exploring the mine by diamond drill. Other shippers in the district were the Old Hickory, Quilp, Old Republic, and Black Tail mines.

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[1] Pardee, J. T., Geology and mineral deposits of the Colville Indian Reservation, Wash.: U. S. Geol. Survey Bull. 677, 1918.

The last-named property has since been purchased by the Northport Smelting & Refining Co. No milling was done in the district, except small tests on high-grade material.

KING COUNTY.

Miller River district.—The Apex mine produced several shipments of arsenical pyrite, which contained considerable gold and silver.

KITTITAS COUNTY.

Swauk district.—Three placers near Liberty produced gold valued at $2,635 and 38 ounces of silver. The Golden Rule and Cedar Creek properties were the largest contributors.

LEWIS COUNTY.

Nisqually district.—The Paradise Mining & Milling Co., near Ashford, made an initial shipment of copper ore.

OKANOGAN COUNTY.

Eighteen deep mines and 3 placers produced 3,592 tons of ore, $1,586 in gold, 32,110 ounces of silver, 169,899 pounds of copper, and 785 pounds of lead, valued in all at $75,717. There was in increase in the quantity of ore treated and in the production of silver and copper. The total value of the ore decreased from $22.54 a ton in 1917 to $21.02 in 1918, and the gold and silver value per ton from $9.93 to $9.30. Nearly all of the ore, 3,588 tons, was shipped directly to the smelters, though there are several milling plants in the county. The ore was classified as 2,984 tons of copper ore, 606 tons of siliceous ore, and 2 tons of lead ore.

Cascade district.—Three properties produced 102 tons of ore, containing $216 in gold, 7,820 ounces of silver, and 1,302 pounds of copper, valued in all at $8,358, or an average value per ton of $81.94. A shipment of rich silver ore was made from the Phil Sheridan property of the Carey M. & M. Co., and shipments of lower-grade ore were made as a test from the American Flag mine. A flotation plant is planned for the latter property.

Conconully district.—Shipments of rich silver ore, containing a little gold and copper, were made from the Arlington property. The ore is principally gray copper, with other copper minerals.

Galena district.—A shipment of silver ore was made from the Central group, and a test shipment of copper ore from the Silver King property.

Meyers Creek district.—A small shipment of copper ore came from the Bi-Metallic property, and the Cuba Line placer produced a few ounces of gold. The Neutral mine, at Chesaw, developed considerable iron ore, which was shipped to Chewelah to be used in the manufacture of ferro-magnesite.

Nespelem (Moses) district.—Three deep mines produced 118 tons of ore, containing $165 in gold and 9,319 ounces of silver, together valued at $9,484, or a value per ton of $80.37. The Double Header was the main producer of silver ore. A recent bulletin[1] fully describes the mines and prospects of this region and the Park City district.

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[1] Pardee, J. T., Geology and mineral deposits of the Colville Indian Reservation, Wash.: U. S. Geol. Survey Bull. 677, 1918.

Okanogan district.—A shipment of siliceous silver ore was made by the Morgan Mines Co.

Palmer Mountain district.—Seven deep mines and 1 placer produced 3,032 tons of ore, $655 in gold, 1,661 ounces of silver, and 161,177 pounds of copper. The value of the district output was $42,127, which is an increase from $25,285 in 1917. All the ore, most of which was copper ore, was shipped directly to smelters. Small shipments were made from the O. K., Owasco, Iron Mask, and Caaba properties, but most of the production came from the Copper World Extension mine, which produced several thousand tons of sulphide copper ore.

PEND OREILLE COUNTY.

Metaline district.—Four deep mines produced 245 tons of ore, containing 264 ounces of silver, 184,734 pounds of lead, and 38,873 pounds of recoverable zinc, valued in all at $16,917, or an average value per ton of $69.05. This was a decrease from 1917, when the district produced 15,093 tons of ore, principally from the Lead-Zinc property. This mine was closed in January, 1918, and later the mill was sold to pay debts. Several shipments of lead ore were made from the Bella May property, and a small shipment from the Schallenberger group. The Sterling Silver Lead Co., which has a small concentration mill, made a test shipment of lead concentrate.

Newport district.—A shipment of lead ore was made from the Comstock mine of the Bead Lake Gold & Silver Mining Co., and a 100-ton concentration plant was purchased from the Western Union Mining Co., of Idaho.

PIERCE COUNTY.

The Tacoma smelting plant was active throughout the year, and an increased quantity of ore and concentrate from Washington mines was treated in 1918, as the Canadian smelters operated under many difficulties resulting from the war. A new stack at Tacoma 572 feet high was completed in 1918. According to a recent statement[1] the plant has three blast furnaces, one reverberatory furnace, and four converters. Ore is received from Alaska, South America, and the Western States. The refinery, one of the largest of the West, is rated at 204,000,000 pounds of copper per annum.

SNOHOMISH COUNTY.

Seven deep mines and 2 placers in Snohomish County produced 12,148 tons of ore, $1,269 in gold, 5,000 ounces of silver, and 452,043 pounds of copper, valued in all at $117,924. This production represents an increase of 9,310 tons of ore and $67,059 in total value. The entire tonnage was copper ore, and most of it was milled. The value per ton decreased from $17.89 in 1917 to $9.68 in 1918.

Granite Falls district.—Several small test shipments of copper ore were made from the vicinity of Granite Falls.

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[1] Eng. and Min. Jour., Jan. 11, 1919, p. 47.

Index district.—Three deep mines produced 12,038 tons of ore, containing $995 in gold, $3,983 ounces of silver, and 421,466 pounds of copper, valued in all at $109,080, or an average value per ton of $9.06. The greater part of this ore was milled and produced copper concentrate. Small shipments of copper ore were made from the Bush & Curry and Ethel properties, but most of the production came from the Sunset mine, which is one of the large copper producers of the State. The new 150-ton mill, which has a jaw crusher, ball mill, tables, and flotation machine, was completed and went into operation in September. Both the crude ore and concentrate were shipped to the Tacoma smelter.

Sultan district.—The only output of the district, other than a small placer production, came from the Florence Rae mine, operated by the Cascade Mining Co., which made several shipments of copper ore of good grade.

STEVENS COUNTY.

Mine production in Stevens County, Wash., in 1917 and 1918.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	39	82,043	$3,757	161,013	1,647,490	9,655,513	18,852	$1,418,494
1918	23	74,232	8,199	168,669	1,170,488	5,077,152	....	826,456
Increase or decrease, 1918	....	−7,811	+4,442	+ 7,656	− 477,002	−4,578,361	−18,852	− 592,038

Gold and silver excepted, there was a general decrease in the output of metals in Stevens County in 1918. Twenty-three deep mines produced 74,232 tons of ore, a decrease of 7,811 tons. The value per ton decreased from $17.29 in 1917 to $11.13 in 1918, but the value in gold and silver increased from $1.66 to $2.38 a ton. Most of the ore, or 62,911 tons, was milled and yielded 3,561 tons of concentrates valued at $311,679, or $87.53 a ton. The remainder, 11,321 tons, was shipped directly to the smelters and had a total value of $514,777, or $45.47 a ton. Of the total output, 65,135 tons were copper ore, 7,902 tons lead ore, and 1,195 tons siliceous ore.

Bossburg district.—The Bonanza mine, formerly an important lead producer, made shipments of dump material containing a small percentage of lead but considerable silver.

Chewelah district.—From 1901 to the end of 1918 this district has produced 267,188 tons of ore, yielding $69,276 in gold, 1,095,014 ounces of silver, 6,810,997 pounds of copper, and 265,139 pounds of lead, having a total value of $2,229,096. Three deep mines in 1918 produced 64,001 tons of ore, containing $6,946 in gold, 142,335 ounces of silver, 994,560 pounds of copper, valued in all at $394,937, or an average value per ton of $6.17. Ten deep mines in 1917 produced 62,436 tons of ore valued at $456,263, or $7.31 a ton. Of the total ore, 62,559 tons were concentrated and 1,442 tons were shipped directly to smelters. Several shipments of copper ore were made from the Amazon and Brown Lake properties, but as usual most of the output came from the property of the United Copper Co., which operated a 200-ton concentration and flotation mill during most of the year. The output was somewhat less than in 1917, owing to difficulty in marketing the product. The following notes are taken from the printed annual report of the company:[1]

> The prevailing costs of all materials and supplies, as well as the wage scale, were the highest ever known, and were increased far in excess of the metal prices. It has cost the company close to 18 cents per pound to produce copper, and the average price received from the smelters has been under 20 cents, so it can readily be seen that the margin of profit has been small.
>
> Owing to extremely small amount of moisture in the ground for the past two years, the water in Colville River almost entirely failed during the summer months of the past year, and as a consequence the Stevens County Power & Light Co. was unable to deliver any power at all some of the time and the output during these months was very light. * * *
>
> * * * The high-grade shoot of ore in the South drift above the 1,000-foot level had been worked out, and nothing [is] left but low-grade ore, carrying 1.5 per cent copper and 2 ounces silver. The caving system of mining was employed, and as the stopes were large and the walls soft, it was impossible to keep out the waste and considerable of it had to go to the mill with the ore, bringing down the mill feed to 0.75 per cent copper and 1 ounce silver. This class of ore could not be made to pay except under the most favorable of circumstances, such as did not prevail last year at any time. * * *
>
> We turned our efforts toward sinking and development below the tunnel level, where we have been successful in finding a much higher grade of ore, carrying slightly more values in copper, and with the highly encouraging feature of more than double the values in silver in all the lower levels. * * *
>
> During the early months of the year we did a considerable amount of development work by drifting and diamond drilling on the Copper King property, which the company holds under bond. Very large bodies of ore were found, but of low grade, which can not be worked at a profit with our present mill equipment. If our mill capacity could be brought up to 800 or 1,000 tons daily capacity with improved equipment, then these large bodies of low-grade ore can be mined and milled at a fair profit. * * *
>
> A considerable amount of money was spent last year in trying to locate the high-grade gray copper ore shoot found in the upper levels of the mine. We were disappointed in our efforts until we reached the 1,200-foot level in the winze where we found some very promising stringers of high grade. We then sunk the winze 75 feet deeper and drifted, and at the time of making this report all indications point to a body of rich silver ore as depth is gained or water level is reached. * * *
>
> For the first eight months of the year 1918 our shipments were going to the Trail smelter, but owing to many shipping and smelting conditions prevailing during the war, it was found advisable to make smelting arrangements elsewhere. This was done in September, when a three-year contract was made at Tacoma, and considering that it was negotiated under war conditions, the contract is a very fair one. This new contract compelled the company to make some changes in the milling operations so as to secure greater capacity, make a higher percentage of savings, and reduce the moisture in concentrates, in order that freight and treatment charges might be kept at the lowest possible point, and with further changes now under way, we hope to bring up the efficiency of our mill to a saving of better than 90 per cent. * * *

The quantity of ore mined was 66,181 tons, from which a production of 142,005 ounces of silver and 987,524 pounds of copper was made. The value of the concentrate was $245,718, and that of crude ore $69,731. Freight cost $23,014; treatment, $16,750; and operating expenses were $234,291. The engineer of the company estimates 50,836 tons above the 1,000-foot level and 45,173 tons of positive ore below that level. In March, 1919, however, considerable rich silver ore was opened below the 1,200-foot level.

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[1] United Copper Mining Co. Thirteenth Ann. Rept., for year ending Dec. 31, 1918.

Loon Lake district.—The Loon Lake mine produced several hundred tons of copper ore. The property is opened to a depth of 500 feet, and in the latter part of the year, after changing hands, plans were made for the building of a flotation plant, which was under construction in 1919.

Northport district.—Eight deep mines produced 7,564 tons of ore, containing 2,408 ounces of silver, 642 pounds of copper, and 5,020,838 pounds of lead, valued in all at $359,046, or an average value per ton of $47.47. The output represents a decided decrease from 15,789 tons of ore, valued at $816,890, in 1917. All the ore was lead material shipped to various smelting plants. The majority of it came from the mine of the Electric Point Mining Co., the operating income of which was $242,538. Expenses of various kinds were $272,704, and the operating loss was $30,166. The tramway installed during the year cost $53,697. The following paragraphs are taken from the printed statement of the company:[1]

> Owing to labor conditions and also to a fire at the Trail smelter our shipments to Trail were restricted to 146 cars during the year 1918.
>
> The Northport smelter took but a limited quantity amounting to but 70 cars during the year 1918.
>
> As a large percentage of our ore was carbonates, we could not ship at a profit to the more distant smelters.

The Northport Smelting & Refining Co. operated the lead smelter at Northport during the year, but shipments of bullion were about 30 per cent less than those of 1917, as the output was curtailed from August to the end of the year. In November work was started on the foundation for a drossing plant. The smelter is equipped with Dwight Lloyd sintering machines, 3 modern blast furnaces, and a Cottrell fume precipitating plant. The charge is made up largely of sulphide ore from Idaho and siliceous ore from Washington, but custom ore is also purchased and thus an impetus was given the mines in the vicinity. Bullion is shipped to Pittsburgh, Pa., for refining.

Other shipments from the district came from the Last Chance property, now operated by the Roland Mining Association, the Lead Trust Co., Melrose, Turquoise, W. J. Bryan, and United Treasure.

Orient district.—There was only one shipment of gold ore of good grade made from the F. H. C. mine.

Spokane Indian Reservation district.—Several shipments of sorted copper ore were made by the O-Lo-Lim Copper Co.

Springdale district.—Five deep mines produced 1,780 tons of ore, containing $302 in gold, 18,657 ounces of silver, 82,727 pounds of copper, and 34,324 pounds of lead, valued in all at $41,829, or an average value per ton of $23.50. Of this ore, 352 tons were concentrated, and the remainder was shipped directly to smelters. This district, which includes the Cedar Canyon region, produces a variety of ores, the most important of which is the copper ore from the Turk mine, worked by the Reardon Copper Co. The Consolidated Mines Co., operating the Deer Trail property, shipped silver ore. A few shipments of lead concentrate were made from the Cleveland property, now under the management of the Santa Rita Mining Co. The mine has a 50-ton mill equipped for concentration and flotation. From the Silver Queen mine several shipments of silver ore were made, and the Golden Seal property produced one shipment of copper ore.

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[1] Electric Point Mining Co. Ann. Rept. for year ending Dec. 31, 1918.

Summit district.—The Silver Mountain property was the source of a test shipment of silver ore, containing a small percentage of lead.

Valley district.—A small shipment of oxidized copper ore came from the Redemption claim.

WHATCOM COUNTY.

Mount Baker district.—The production of the Mount Baker district was unimportant on account of the idleness of the Boundary Red Mountain property, near Sumas. During 1916 and 1917 this mine was a considerable contributor to the output of gold in Washington.

BAUXITE AND ALUMINUM.

By James M. Hill.

BAUXITE.

DOMESTIC PRODUCTION.

The quantity of bauxite marketed in the United States in 1918 was 605,721 long tons, which had a value at the mines of $3,447,992 an increase over the production of 1917 of about 7 per cent in quantity and about 11 per cent in value. The production from the Georgia, Alabama, and Tennessee fields in 1918 was 42,829 long tons, a decrease of 31 per cent, but the Arkansas production of 562,892 long tons showed an increase of approximately 11 per cent.

Of the quantity of domestic bauxite marketed in 1918, apparently the producers of aluminum took about 419,043 long tons, the makers of chemicals about 63,896 tons, makers of abrasives about 112,908 tons, and the makers of refractories about 9,874 tons. As will be noted, the total quantity of domestic bauxite marketed is 16,058 tons greater than the apparent domestic consumption given in the table below. It is believed that this discrepancy is in part due to stocks carried at consuming works, and in part to loss in the manufacture of "refined bauxite," the product that is largely exported.

As will be seen by the table, the domestic consumption of bauxite in 1918 increased about 6 per cent over the consumption in 1917, and the domestic deposits supplied nearly the whole demand. The larger part of the exports were apparently made to Canadian aluminum and abrasive makers.

Bauxite produced and consumed in the United States, 1914–1918.

Year.	Domestic production.					
	Georgia, Alabama, and Tennessee.		Arkansas.		Total.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity. (long tons).	Value.
1914	24,071	$92,508	195,247	$976,686	219,318	$1,069,194
1915	28,245	144,345	268,796	1,370,489	297,041	1,514,834
1916	49,190	284,810	375,910	2,011,590	425,100	2,296,400
1917	62,134	395,051	506,556	2,724,007	568,690	3,119,058
1918	42,829	314,112	562,892	3,133,880	605,721	3,447,992

Bauxite produced and consumed in the United States, 1914–1918—Continued.

Year.	Imports.		Exports.[a]		Domestic consumption.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1914	24,844	$96,500	[b]5,374	[b]$240,084	238,788	$925,610
1915	3,420	17,107	16,082	717,186	284,379	814,755
1916	30	87	17,939	987,454	407,191	1,309,033
1917	7,691	28,989	21,791	1,323,926	554,590	1,824,121
1918	3,653	14,791	19,711	1,523,688	589,663	1,939,095

[a] Includes bauxite concentrates.

[b] Figures cover six months, July to December, 1914. Not separately classified by Bureau of Foreign and Domestic Commerce prior to July, 1914

The first bauxite produced in the United States was that obtained in 1889 from deposits in the north Georgia field. In 1891 the Alabama deposits made their first production, and practically all the bauxite mined in the United States until 1899 came from these two States. The Arkansas deposits made their first output in 1896, but it was not until 1900 that their influence was felt. In 1907 the Tennessee deposits first began shipping. The following table gives a historical record of the remarkable growth of the bauxite industry in the United States, which has been particularly rapid in the last 10 years. The diagram (fig. 4) gives the same facts in a graphic way.

In the historical table the figures under "Shipments" and "Production" do not agree for all years. It is believed that the figures under "Shipments" give the true measure of the bauxite production, for bauxite is ordinarily shipped as soon as it is mined. In fact, since 1915 the United States Geological Survey has published figures of shipments as representative of production.

The figures in the column headed "Shipments" were compiled from revised figures of bauxite shipped by the American Bauxite Co. and the Republic Mining & Manufacturing Co. which were supplied to the Geological Survey through the courtesy of these companies. The old figures of production as published by the Geological Survey are printed for comparison, but the revised figures are believed to represent more accurately the condition of the industry.

The Geological Survey's published figures of production have been widely quoted, and as the discrepancies between the revised shipment figures and the old production figures are not great, it has been decided best not to revise the summary tables of mineral production of the United States with regard to bauxite.

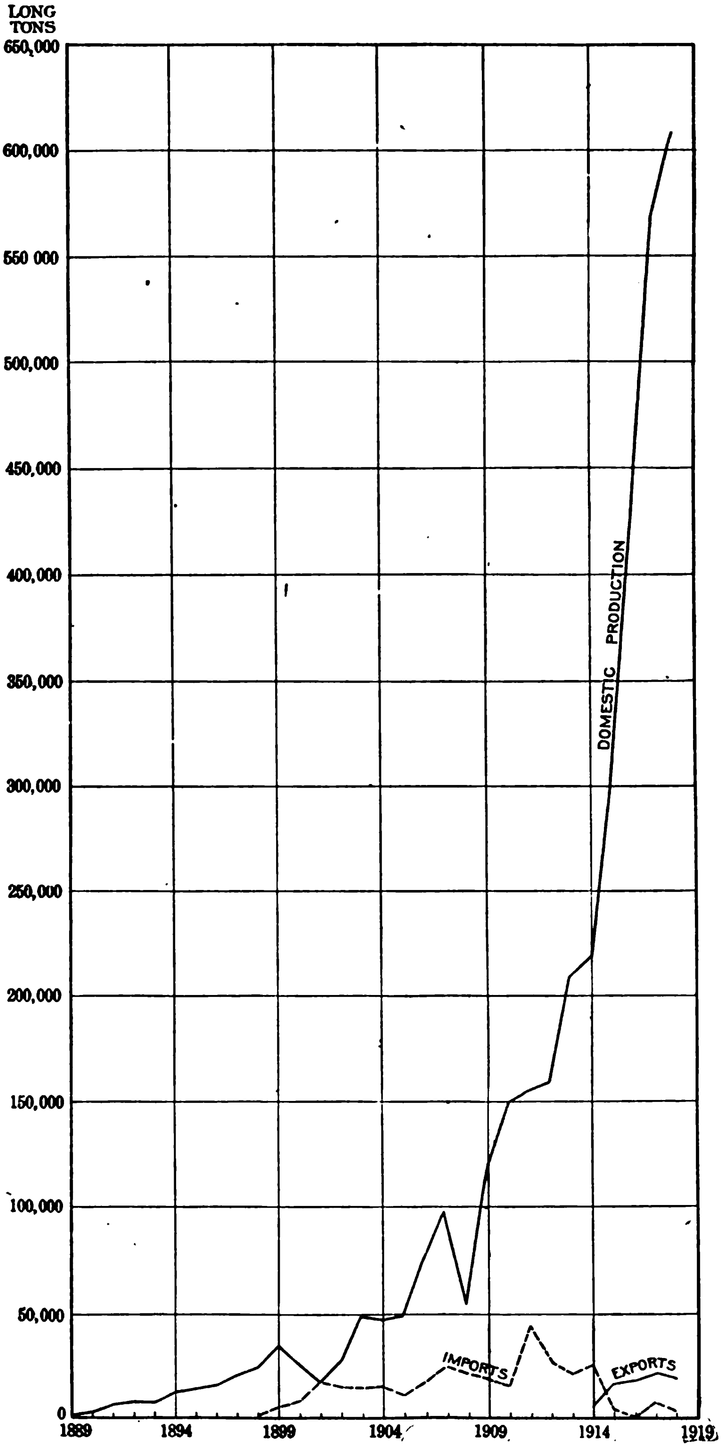

FIGURE 4.—Production, imports, and exports of bauxite, 1889–1918.

Bauxite produced, imported, and exported since the beginning of mining in the United States 1889–1918, in long tons.

Year.	Shipments as revised by producers, December, 1919.	Domestic production as reported by United States Geological Survey.	Imports.[a]	Exports.[b]
1889	728	728	...	...
1890	1,844	1,844	...	...
1891	3,593	3,593	...	...
1892	10,598	10,518	...	...
1893	9,179	9,179	...	...
1894	11,066	11,066	...	...
1895	17,069	17,069	...	...
1896	18,404	18,364	...	...
1897	20,590	20,590	...	...
1898	24,944	25,149	1,201	...
1899	32,943	35,280	6,666	...
1900	23,406	23,184	8,656	...
1901	19,870	18,905	18,313	...
1902	27,340	27,322	15,790	...
1903	44,726	48,087	14,889	...
1904	50,962	47,661	15,374	...
1905	56,634	48,129	11,726	...
1906	70,607	75,332	17,809	...
1907	94,360	97,776	25,066	...
1908	50,085	52,167	21,679	...
1909	132,213	129,101	18,688	...
1910	151,003	148,932	15,669	...
1911	157,006	155,618	43,222	...
1912	161,125	159,865	26,214	...
1913	210,740	210,241	21,456	...
1914	218,618	219,318	24,844	[c]5,374
1915	299,797	297,041	3,420	16,082
1916	425,120	425,100	80	17,939
1917	568,690	568,690	7,691	21,791
1918	605,721	605,721	8,653	19,711
	3,518,981	3,511,570		

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[a] Not separately classified prior to 1898.

[b] Not separately classified by Bureau of Foreign and Domestic Commerce prior to July, 1914. Figures include bauxite concentrates.

[c] Figures cover six months, July to December.

MARKET AND PRICES.

The market for bauxite in the United States is east of Mississippi River, and the largest consumers are located at or near the cities of East St. Louis and Aurora, Ill.; Detroit, Mich.; Cincinnati, Ohio; Knoxville, Tenn.; Philadelphia and Erie, Pa.; Niagara Falls and New York City, N. Y.; and Boston, Mass. Recently a number of municipal and industrial waterworks have installed small plants for the manufacture of aluminum sulphate for local use in purification of water. A complete list of those known to the United States Geological Survey to be users of bauxite follows:

Aluminum Co. of America, Pittsburgh, Pa.
Booth Chemical Co., P. O. Box 203, Elizabeth, N. J.
Carborundum Co., Niagara Falls, N. Y.
Charles Lennig & Co. (Inc.), 112 South Front Street, Philadelphia, Pa.
Charles Taylor Sons Co., Cincinnati, Ohio.
Columbus Waterworks, R. D. 5, Columbus, Ohio.
Cumberland Waterworks, R. D. 3, Cumberland, Md.
Detroit Chemical Works, 238 Junction Avenue, Detroit, Mich.
E. I. du Pont de Nemours Powder Co., Wilmington, Del.
Erie Chemical Works, 31 Union Square W., New York, N. Y.
Exolon Co., 156 Sixth Street, Cambridge, Mass.

General Abrasives Co., Niagara Falls, N. Y.
General Refractories Co., Trinity Building, New York, N. Y.
Harbison-Walker Refractories Co., Pittsburgh, Pa.
Jarecki Chemical Co., St. Bernard Station, Cincinnati, Ohio.
Laclede-Christy Clay Products Co., St. Louis, Mo.
Massillon Stone & Fire Brick Co., Massillon, Ohio.
Merrimac Chemical Co., 33 Broad Street, Boston, Mass.
Metropolitan Water District of Omaha, Omaha, Nebr. (R. B. Howell, general manager.)
Montclair Waterworks, Little Falls, N. J.
Norton Co., Worcester, Mass. (also Niagara Falls, N. Y.).
Pennsylvania Salt Manufacturing Co., Widener Building, Philadelphia, Pa.
Springfield Waterworks, Springfield, Mass.
Superior Chemical Co., Joliet, Ill.

Bauxite is graded according to its chemical composition and is sold to the consuming industries on the basis of analysis. Apparently low content of silica and titanium is essential to the aluminum industry, but the content of iron may be fairly high, though bauxites low in iron and titanium are preferred by the makers of alum and aluminum sulphate. Makers of abrasive appear to be able to use bauxites of lower grade and containing larger proportions of silica and iron than are permissible in bauxite for other uses, but abrasives are made from bauxites low in silica and iron. The bauxite used for refractories must apparently be fairly low in iron.

The prices received for bauxite in 1918, as reported by producers, ranged from $5 to $12 a long ton; the average price paid for the whole of the domestic bauxite sold in this country was $5.69 a long ton at the shipping point. It must be realized that the average price computed from the assigned value of the total production is considerably below the price at which bauxite can be purchased in small lots, because of the fact that the larger consumers operate their own mines and assign to the output an arbitrary value, which is presumably based on operating costs.

WORLD'S PRODUCTION.

Data on the output of the French bauxite mines have been withheld since the beginning of the war.

World's production of bauxite, 1914–1917.

Country.	1914		1915		1916		1917	
	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.
United States	222,827	$1,069,194	301,794	$1,514,834	431,902	$2,296,400	577,789	$3,119,058
France	(a)	(a)	(a)	(a)	[b] 23,412	(a)	[b] 38,115	(a)
United Kingdom [c]	8,419	10,507	11,911	15,393	10,494	14,477	14,960	20,106
Italy [d]	3,906	9,046	6,608	15,942	8,886	(a)	7,789	67,647
India [e]	522	156	(a)	141	762	2,253	1,385	3,017

[a] Statistics not available.

[b] Production in Cette consular district, France, only. Supplement to Commerce Reports No. 52, U. S. Dept. Commerce, Dec. 5, 1918.

[c] Value given in official report as pounds; conversion factor $4.85=£1.

[d] Value given in official report as lire; conversion factor $0.193=1 lira.

BAUXITE IN THE UNITED STATES.

The bauxite deposits of the United States are in central Arkansas, northeastern Alabama, northwestern Georgia, southern-central Tennessee, central and central-western Georgia, and northeastern Tennessee, as shown on the map (Pl. III).

The bauxite from all localities in the United States, though it may vary in chemical composition, is on the whole similar in general appearance, with the exception of the "granitic bauxite" of the Arkansas field. The greater part of the American bauxite appears to be made up of rounded pebble-like bodies set in a fine-grained matrix, which may also consist of small rounded particles or may be as fine grained as the finest clay. The pebble or pisolite form is so general that it is the conspicuous characteristic of American bauxite.

There is only one way to determine the value of bauxite, and that is by chemical analysis, which should show total silica, alumina, titanium oxide, iron oxide, and water. Bauxites of commercial grade should carry at least 52 per cent of alumina.

Some measure of the relative quality of dried bauxite can be had by grinding a sample in an agate mortar for half a minute. A bauxite of good grade will be found hard to grind and will stick to the mortar with such tenacity that it will have to be scoured out; a poor bauxite or bauxitic clay will grind much more easily and will stick very little, if at all; and clay or kaolin grinds with ease and does not stick to the mortar. Similar results are found if the sample is rubbed on glass; the glass will not be scratched by even high-grade bauxite.

The principal bauxite deposits in the United States have been described in the papers listed below:

ARKANSAS FIELD.

Beyer, W. F. B., Bauxite in Arkansas: Eng. and Min. Jour., Apr. 14, 1904, pp. 606–607.

Branner, J. C., Bauxite in Arkansas: Am. Geologist, vol. 12, pp. 181–183, 1891. Jour. Geology, vol. 5, pp. 263–289, 1897.

Hayes, C W., Arkansas bauxite deposits: U. S. Geol. Survey Twentieth Ann. Rept., pt. 3, pp. 441–471, 1901.

Mead, W. S., Occurrence and origin of the bauxite deposits of Arkansas: Econ. Geology, vol. 10, pp. 28–54, 1915.

Williams, J. F., Igneous rocks of Arkansas: Arkansas Geol. Survey, Ann. Rept., vol. 2, 1890.

GEORGIA, ALABAMA, AND TENNESSEE FIELD.

Ashley, G. H., Bauxite mining in Tennessee: Resources of Tennessee, vol. 1, No. 6, pp. 211, 219, 1911.

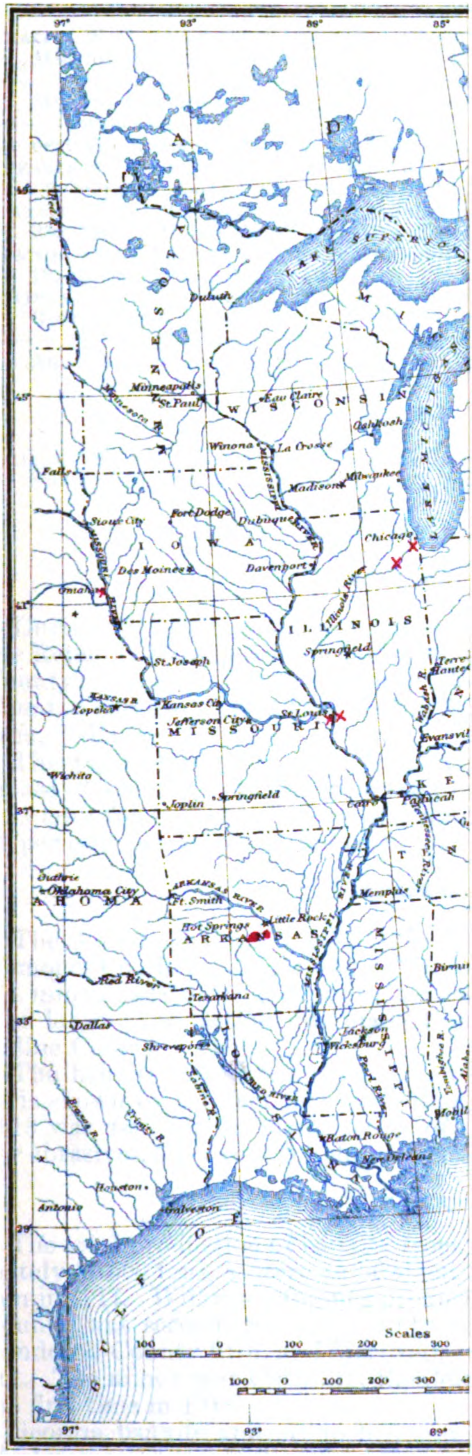
Hayes, C. W., Bauxite: U. S. Geol. Survey Sixteenth Ann. Rept., pt. 3, pp. 547–597, 1895.

——— The geologic relations of the southern Appalachian bauxite deposits: Am. Inst. Min. Eng. Trans., vol. 24, pp. 243–254, 1895.

McCallie, Henry, Alabama bauxite: Alabama Industrial and Scientific Soc. Proc., 1893.

——— The valley regions of Alabama, pt. 2, pp. 79–84, Alabama Geol. Survey, 1897.

——— Bauxite deposits of southern Georgia: Eng. and Min. Jour., May 27, 1911, p. 1050.


97°
93°
88°
85°
45°
41°
37°
33°
29°
LAKE SUPERIOR
LAKE MICHIGAN
MINNESOTA
WISCONSIN
IOWA
ILLINOIS
MISSOURI
ARKANSAS
LOUISIANA
MISSISSIPPI
OKLAHOMA
GULF OF
Duluth
Minneapolis
St. Paul
Eau Claire
Oshkosh
Winona
La Crosse
Madison
Milwaukee
Falls
Sioux City
Fort Dodge
Dubuque
Chicago
Des Moines
Davenport
Omaha
Springfield
St. Joseph
Terre Haute
Kansas City
Topeka
St. Louis
Jefferson City
Evansville
Wichita
Joplin
Springfield
Cairo
Paducah
Guthrie
Oklahoma City
Ft. Smith
Memphis
Hot Springs
Little Rock
Birmingham
Red River
Texarkana
Dallas
Jackson
Vicksburg
Shreveport
Mobile
Baton Rouge
New Orleans
Houston
Galveston
Antonio
Mississippi River
Missouri River
Illinois River
Kansas R.
Arkansas River
Wabash R.
Tennessee River
Minnesota
Sabine R.
Red River
Pearl River
Tombigbee R.
Brazos R.
Trinity R.
Scales
100
0
100
200
300
100
0
100
200
300

MAP SHOWING LOCATION C
FACTURING BAUXITE PR

Phalen, W. C., Production of bauxite and aluminum in 1907: U. S. Geol. Survey Mineral Resources, 1907, pt. 1, pp. 695–698, 1908.

——— Production of bauxite and aluminum in 1912: U. S. Geol. Survey Mineral Resources, 1912, pt. 1, p. 951, 1913.

——— Production of bauxite and aluminum in 1913: U. S. Geol. Survey Mineral Resources, 1913, pt. 1, pp. 3–10, 1914.

Shearer, H. K., A report on the bauxite and fuller's earth of the Coastal Plain of Georgia: Georgia Geol. Survey Bull. 31, pp. 19–140, 1917.

Spencer, J. W., The geology of 10 counties of northwestern Georgia, pp. 214–239, 1893. (Published by authority of Georgia Geol. Survey.)

Veatch, Otto, Bauxite of Wilkinson County, Ga.: Georgia Geol. Survey Bull. 18, pp. 430–447, Atlanta, 1909.

Watson, T. L., A preliminary report on the bauxite deposits of Georgia: Georgia Geol. Survey Bull. 11, 1904.

——— The Georgia bauxite deposits, their chemical constituents, and genesis: Am. Geologist, vol. 28, pp. 25–45, 1901.

VIRGINIA.

Phalen, W. C., Production of bauxite and aluminum in 1908: U. S. Geol. Survey Mineral Resources, 1908, pt. 1, pp. 698–699, 1909.

NOTES ON THE BAUXITE MINES, BY STATES.

ALABAMA.

During 1918 three companies were operating in the Alabama field—the Republic Mining & Manufacturing Co., near Rock Run, Cherokee County; the Consolidated Mining Co., near Fort Payne, Dekalb County; and the Expert Prospecting & Development Co., near Talladega, Talladega County.

The production of bauxite from Alabama in 1918 showed a decrease of about 40 per cent from the production in 1917. The output was used for the manufacture of alumina chemicals to the extent of 79 per cent; abrasives, 17 per cent; and refractories, 4 per cent.

ARKANSAS.

The American Bauxite Co., Globe Bauxite Co., E. I. du Pont de Nemours Co., Republic Mining & Manufacturing Co., and the Norton Co. mined bauxite from deposits in Saline and Pulaski counties, Ark. The largest production was made from the deposits near Bauxite, Saline County.

The bauxite mined from the Arkansas deposits is of high grade, as is shown by the fact that more than 75 per cent of the output in 1918 was used for the manufacture of aluminum, nearly 18 per cent for abrasives, 5 per cent for chemicals, and 2 per cent for refractories.

GEORGIA.

The total production of bauxite from Georgia in 1918 was approximately 36,500 tons, a decrease of about 30 per cent from the production in 1917. Wilkinson County produced the largest quantity, Floyd County was second, Sumter County third, Bartow County fourth, Randolph County fifth, and Meriwether County sixth in rank of output. The mines near Cuthbert, Randolph County, were operated for the first time in 1918.

Georgia bauxite appears to be more suitable for the manufacture of alumina chemicals than for other purposes. The consumption of the output in 1918 was distributed as follows: Eighty-two per cent for alumina chemicals and 18 per cent for abrasives.

NEW MEXICO.

The impression seems to have prevailed that the alunogen deposits in Grant County, N. Mex., are bauxite. These deposits were first described by Blake[1] and also in more detail in a privately printed pamphlet.[2] They were described in considerable detail by Hayes,[3] who found that the deposit was a very highly altered volcanic breccia outcropping in a more or less circular area surrounded by basalt. He states that this breccia probably represents a core of an andesitic volcano which broke through the basalt flow of the surrounding region and that the alteration of the brecciated andesite was probably due to the escape of volcanic gases which followed the intrusion. The altered breccia Hayes shows by analyses to be "essentially the silicate of alumina," and not bauxite. There are large quantities of alumina sulphate and iron-alumina sulphate which form as incrustations from 2 to 4 feet thick on the surface, and probably considerable soluble sulphate in the porous altered breccia. At present, however, there seems to be little possibility of utilization of this material on account of its inaccessibility.

TENNESSEE.

The bauxite deposits on Missionary Ridge were reported idle during 1918. A small output was made at the mines near Elizabethton, Carter County, Tenn.

HIGH-ALUMINA CLAYS.

The possibility of making use of high-alumina clays in place of bauxite, particularly in the manufacture of abrasives and refractories, should not be lost sight of. The deposits of fire clay in central Missouri contain considerable quantities of clay which carries more than 50 per cent of alumina, though from the information now available it is not possible to give an idea of the quantity of material of this character that is available.[4] The high-alumina clays are made up of diaspore ($Al_2O_3+H_2O$), which occurs in varying proportions in ordinary fire clay. The higher-grade clays are usually harder than the fire clays and appear somewhat sandy or porous. There is no regularity in the distribution or occurrence of the lenses of high-alumina clays within the fire-clay beds.

The Survey has received samples of high-alumina clay from southern California and Washington, though no definite information is at hand as to the occurrence of the beds from which the samples came.

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[1] Blake, W. P., Alunogen and bauxite of New Mexico: Am. Inst. Min. Eng. Trans., vol. 24, pp. 571–573, 1894.

[2] Prospectus: The Alum Mountain property, New Mexico.

[3] Hayes, C. W., The Gila River alum deposits: U. S. Geol. Survey Bull. 315, pp. 215–223, 1916.

[4] The diaspore clays of Missouri will be described in detail in a forthcoming bulletin of the U. S. Geological Survey by Heinrich Ries, entitled "High-grade clays of the eastern United States."

BAUXITE IN FOREIGN COUNTRIES.

EUROPE.

France.—In the south of France, particularly in the Provinces of Var, Herault, Bouches du Rhone, and several other Provinces, bauxite occurs in thick beds associated with folded Cretaceous rocks. Beds of bauxite alternate with clays and limestones that are believed to have been of lacustrine origin, and the theory has been advanced that the bauxite was formed by mineral springs or geysers. These deposits have furnished the world with large quantities of high-grade bauxite.

Germany.—In the Vogelsberg Mountains, Hesse, and near Konigswinter, in the lower Rhine region, Germany, low-grade bauxites are found that have resulted from the alteration of basalt. These bauxites were considered of little economic importance before the war, but have probably been used to some extent since 1914.

Austria.—Extensive deposits of bauxite of fairly good grade have been worked in the Bihar Mountains of central Austria. These deposits, like the French, are associated with Cretaceous limestone. Similar deposits of bauxite in Dalmatia have been exploited during the last two years, and it is known that there are bauxite deposits of similar occurrence in the Velebit Mountains of Croatia and in the Province of Istria.

Italy.—In the central part of Italy in the Apennine Mountains there are extensive bauxite deposits associated with Cretaceous rocks, similar to the French deposits, which have supplied the aluminum industry of Italy during the last few years.

Spain.—Bauxite deposits have recently been found in eastern Spain in the Provinces of Barcelona and Tarragona. It is reported that these deposits are associated with Triassic rocks.

Ireland.—The bauxite deposits in the county of Antrim, Ireland, have been worked for a considerable time. They are derived from the alteration of basalts and are not of particularly high grade.

SOUTH AMERICA.

Guiana.—Some information has been given concerning the very extensive bauxite deposits in British and Dutch Guiana. In the British Colony large holdings on Demerara River about 60 miles above Georgetown, in the foothill region, are now under development and some shipments of high-grade bauxite have been made. The bauxites are aluminous laterites derived from the alteration of gneissic rocks and are presumably of widespread occurrence in the foothill region that roughly follows the north coast of South America. In Dutch Guiana the geologic conditions are similar, though the belt in which bauxite deposits may be expected is nearer the coast. A little bauxite has been found in French Guiana, but here the mountains approach the sea and it is probable that the foothill area in which bauxite may be found is rather narrow.

Brazil.—It is reported that bauxite has been discovered in Para River, presumably in northeastern Brazil, and highly aluminous material is found in the lateritic iron deposits in Minas Geraes.

AFRICA.

There are many scattered notes throughout geologic literature concerning laterites, some of which are highly aluminous, in most of equatorial Africa. Laterites are reported in such widely scattered localities as Ashanti, Rhodesia, Nigeria, Kongo, and French Guinea. Of particular interest are the bauxite deposits in French Guinea, which have resulted from the alteration of gneisses and feldspathic igneous rocks; these deposits are reported to be under development.

INDIA.

The literature on the geology of India contains many references to laterite. The highly aluminous laterites are apparently most abundant in the Jubbulpore, Chota Nagpur, and Balaghat districts in central India, near Concan on the west coast south of Bombay, and in the Palni Hills in south India.

AUSTRALIA.

Numerous references concerning the occurrence of laterites in Australia are to be found both in the Government reports and in technical journals, which indicate that the possibility of discovering bauxite deposits in that country is good.

ALUMINUM.

DOMESTIC PRODUCTION AND CONSUMPTION.

The value of primary aluminum produced in the United States in 1918 was $41,159,225, a decrease of about 10 per cent from the value of the output in 1917. The decrease was due very largely to the decline in price of aluminum during 1918 and does not represent a corresponding decline in quantity of output.

Value of aluminum produced and consumed in the United States, 1913–1918.

Year.	Domestic production.		Imports.[b]	Exports.[c]	Apparent consumption.
	Primary metal.	Secondary metal.[a]			
1913	$9,450,000	$2,199,480	$4,784,302	$966,094	$15,467,688
1914	10,080,000	1,673,140	4,074,583	1,546,510	14,281,213
1915	16,280,000	5,802,100	1,841,779	3,682,117	20,241,762
1916	83,900,000	23,430,200	1,785,870	15,417,134	43,698,936
1917	45,882,000	16,711,800	56,890	14,586,467	48,064,223
1918	41,159,000	10,113,600	554,586	10,869,388	40,957,798

[a] Value based on average open market price, as quoted by Eng. and Min. Jour.

[b] Imports for consumption, figures from Department of Commerce reports. Includes aluminum in crude form, leaf, sheets, plates, bars, strips, wire, rods, and all manufactures of; table, kitchen, and hospital ware.

[c] Exports of aluminum and manufactures of; figures from Department of Commerce reports.

MARKET AND PRICES.

There were practically no open-market dealings in aluminum during 1918, as the industry was essentially under Government regulation. The supply of aluminum was not large and little of the metal was used except for war purposes.

Price in cents per pound

Open-market prices of 37 cents a pound were quoted until March 2, 1918. On March 4 the base price for sales of aluminum was fixed by the Government at 32 cents a pound, but this was raised to 33 cents a pound on June 1, 1918, and remained unchanged till the end of the year. The fixed price was early interpreted to cover secondary aluminum as well as primary. The average price for the year was 33.6 cents a pound. The open-market prices of aluminum for the years 1914 to 1918, inclusive, as given weekly by the Engineering and Mining Journal, are of interest as showing the uncertainty of the market concerning the supply of aluminum to meet peace demands as well as the heavy drafts for war purposes. It is also interesting to note that the Government-fixed base price was in essential accord with the prevailing contract price under which the single producer of aluminum sold most of the output in 1916 and 1917. The facts presented in the following table are shown graphically in Plate IV. It will be noted that there was a slight increase in price at the time of the declaration of war in Europe, followed by a corresponding decline. With the large orders from foreign countries early in 1915 the market advanced rapidly but did not attain its maximum until late in 1916. During 1917, presumably under the unified Allied buying arrangements which did away with so much competitive bidding, the price declined as rapidly as it had risen, and it remained almost stationary at the maximum contract price of the largest producers in 1917 until the Government fixed the price on March 4, 1918.

Open-market prices of aluminum, 1914–1918, in cents per pound.

Month.	1914	1915	1916	1917	1918
January	18.81	19.08	55.00	59.20	37.10
February	18.81	19.22	58.00	58.30	37.00
March	18.50	19.00	60.25	59.20	32.00
April	18.16	18.88	59.50	60.00	32.00
May	17.95	22.03	59.00	60.00	32.00
June	17.75	30.00	61.50	60.00	33.00
July	17.66	32.38	60.20	56.10	33.00
August	19.88	34.50	60.00	49.00	33.00
September	19.94	47.75	61.88	43.20	33.00
October	18.50	50.00	65.05	39.30	33.00
November	18.00	57.75	65.12	36.70	33.00
December	18.96	57.13	63.00	37.00	33.00

NOTES ON THE ALUMINUM INDUSTRY.

Expansion of the plant capacity of domestic makers of aluminum continues. Though war conditions have interfered with the completion of some projects, at others changes have been made which should result in greater output.

Two very interesting papers have been published within the year on the European practice of making aluminum.

Anonymous, Aluminum (bauxite) deposits and the production of aluminum: Engineering (London), vol. 166, pp. 163–165, 191–193, 218–220, 1918.

Nissen, O., Aluminum manufacturing processes used in Europe (translated from Teknisk Tidskrift, Aug., 1917): Chem. and Met. Engineering, vol. 19, pp. 804–815, December, 1918.

In both these papers notes on the making of alumina and artificial cryolite are given, as well as more or less detailed information on electric-furnace practice. The paper in Engineering gives considerable information relative to the capacity of various aluminum works in Europe and also considerable discussion of the supplies of raw materials available to European makers of aluminum. Nissen's article deals principally with the metallurgy of the metal. He discusses briefly the history of the manufacture of aluminum and the development of electric furnaces for this purpose; he notes also the manufacture of alumina by the Deville-Pechery and Bayer processes, and mentions various modifications of these processes for the treatment of high-silica bauxites. The methods of manufacture of artificial cryolite and carbon electrodes, those absolutely essential materials in the manufacture of aluminum, are also pointed out by Nissen, and he gives notes on the actual smelting of the metal.

A comprehensive work on the use of aluminum in the industries by Escard[1] has recently been published. It is impossible in this report to review the work adequately. Some information is given concerning the metallurgy of aluminum, though the book deals primarily with the utilization of aluminum and its alloys.

There can be little question that the aluminum industry of the central European powers has seen considerable change during the war period. In all probability we shall soon learn of the possibility of using very low grade bauxite, or possibly clay, for the manufacture of alumina low enough in silica for the production of high-grade metal. In this connection it is of interest to note that the by-product alumina formed in the separation of potash from alunite is now being marketed. Apparently this material has not yet been found satisfactory for other uses than refractories and abrasives, though patents for its use in the preparation of aluminum have been granted.

The British Aluminum Co., whose plants are at Foyers and Lockleven, had contemplated great expansion during 1918, but their plans do not appear to have materialized, as the House of Lords failed to grant permission for the necessary extensive hydroelectric development in Scotland. This company controls the aluminum works at Higeland and Strangfiord, Norway.

L'Aluminum française is the selling agency for the three aluminum makers of France. These are:

Compagnie des produits chimiques d'Alais et de la Camargue; plants at Calypso, St. Jean de Maurienne, Chedde, and Auzat.

Société électro-métallurgique française; plants at La Praz, St. Michel de Maurienne, and Largentière.

Société d'électrochimie; plants at Premont and Martigny.

Previous to 1917 there were five producers of aluminum in France, but the Compagnie des produits chimiques d'Alais et de la Camargue absorbed the Société des forces motrices de l'Arve and the Société électro-métallurgique des Pyrénées. This company also operates the aluminum works at Arendal and Tyssedal, Norway.

In the countries of the central powers the aluminum industry is largely in the hands of the German-Swiss Société suisse pour l'industrie de l'aluminum, otherwise Aluminum Industrie, A. G., whose plants are at Neuhausen, Chippes, Navisance, and Borgne in Switzerland, at Rheinfelden in Germany, and at Lend and Rauris in Austria. A smaller company, Gebrüder Giuline, which has apparently been reorganized during the war as the Aluminum Fabrik-Martigny, A. G., operates an aluminum works at Martigny.

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[1] Escard, Jean, L'aluminum dans l'industrie, Paris, H. Dunod et E. Pinat, 1918.

Aluminum is produced in Italy at Villeneuve and Bussi by the Società italiana per la fabricazione dell' alluminio.

It is reported [1] that Tata, Sons & Co., the great Indian iron makers, have plans for the erection of an aluminum works at Jargarh, on the western coast of India.

OTHER BAUXITE PRODUCTS.

A little more than 69 per cent of the domestic output of bauxite in 1918 went into aluminum, manufacturers of aluminum salts used about 10 per cent, 19 per cent was consumed in the manufacture of bauxite abrasives, and 2 per cent was used by makers of "high-alumina refractories," also called bauxite brick.

Within the last two years many foreign and domestic patents have been issued relating to the use of bauxite in the fixation of nitrogen, the manufacture of aluminum salts, and the fabrication of abrasives and refractories. Copies of these patents may be obtained from the United States Patent Office, Washington, D. C.

ALUMINUM SALTS.

The principal aluminum salts made in the United States are alumina, alums, usually ammonium and sodium alums, aluminum sulphate, and aluminum chloride. Alumina is largely consumed in the manufacture of aluminum, and no figures of domestic production are available for publication.

Alums of various qualities are produced at 9 plants in the eastern United States, the total production of alum in 1918 being 20,286 short tons, valued at $1,051,449, an increase of approximately 3 per cent in quantity and value over the production in 1917. The average price reported by makers of alums was $51.83 a short ton.

Aluminum sulphate is made at 24 plants, 7 of which are at municipal or industrial waterworks, which consume their entire output. The total quantity of aluminum sulphate produced in the United States in 1918 was 209,079 short tons, of which 7,002 short tons did not enter the market but was used for water purification at the place of manufacture. The quantity of domestic aluminum sulphate which entered the market, 202,077 short tons, was greater than the quantity in 1917 by approximately 16 per cent, and the total domestic production increased about 17 per cent. The price reported by makers of aluminum sulphate for the output in 1918 averaged $30.96 a short ton.

Aluminum chloride is used for various purposes, among which may be mentioned the refining of mineral oils. This salt was produced at three plants in 1918, and the total output reported to the Geological Survey was 4,224 short tons, valued at $338,710, or approximately $80 a short ton.

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[1] Min. Mag. (London), May, 1918.

Alum and aluminum sulphate produced in the United States and aluminum salts imported, 1914–1918.

Year.	Production.						Imports.[a]	
	Alum.			Aluminum sulphate.				
	Quantity (short tons).	Value.	Price per ton	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.
1914	18,238	$565,989	$31.03	164,954	$2,942,572	$17.84	2,891	$73,028
1915	24,915	699,256	28.07	169,153	3,224,495	19.06	1,408	34,320
1916	27,257	1,177,881	43.21	153,860	4,410,741	28.67	1,247	68,660
1917	19,714	1,017,063	51.60	178,738	5,746,427	32.15	507	39,088
1918	20,286	1,051,449	51.83	209,079	6,473,086	30.96	231	18,519

[a] Includes alumina, aluminum hydrate or refined bauxite, alum, alum cake, aluminum sulphate, aluminous cake, and alum in crystals or ground.

BAUXITE ABRASIVES.

Bauxite abrasives sold under various trade names, such as alundum, aloxite, exolon, and lionite, are made by fusing bauxite in an electric furnace. These products are sold in the form of powders, cloth, grinding stones, and wheels of various shapes, and for a multitude of uses. Owing to the objection of one of the large producers, it is not possible to give figures of production of bauxite abrasives for 1918. The marketed production in 1917 was 48,460 short tons, which was made from approximately 109,580 long tons of bauxite. In 1918 approximately 112,908 long tons of bauxite was used for the manufacture of abrasives.

HIGH-ALUMINA REFRACTORIES.

There are two classes of high-alumina refractories now on the market. What are commonly called bauxite brick are made by mixing various proportions of calcined bauxite or high-alumina clay with a bonding material such as fire clay, sodium silicate, or lime. Refractories of this character are being made by the Laclede Christy Clay Products Co., the Harbison-Walker Refractories Co., Charles Taylor & Sons, and the Massillon Stone & Fire Brick Co. Not all the refractories made by these companies are sold as bauxite brick, and, in fact, some do not contain bauxite. The other class of high-alumina refractories consists of those made by the electric fusing of bauxite. These are manufactured by the companies that make artificial abrasives.

The use of high-alumina refractories seems to be expanding, particularly in the construction of copper, iron, and lead furnaces and of cement kilns. No figures are available to show the production of high-alumina refractories, though it is known that at least 2,313 long tons of bauxite was consumed in making refractories in 1917 and, apparently, 9,874 long tons in 1918.

IRON ORE, PIG IRON, AND STEEL.[1]

By Ernest F. Burchard.

INTRODUCTION.

The year 1918, which witnessed the supreme effort of the United States and the Allies to bring the European war to a victorious end, was characterized in the American iron and steel industry by almost complete devotion to the needs of the Government for war purposes. Viewed as a whole the period shows a great contrast between the unsatisfied demand and fixed prices entailed by war conditions at the beginning of the year and the low demand and decreased prices due to the cessation of hostilities and the hesitancy of the normal market at the end of the year.

At several periods there were unusual handicaps to production and shipments. In the winter heavy snows in the Northern and Eastern States congested freight traffic, and severe cold also adversely affected railway operations as well as manufacturing conditions; seaboard terminal facilities are said to have been inadequate to the forwarding of iron and steel products to the expeditionary forces; embargoes and priorities on delivery of supplies and on movement of freight were confusing; and fuel supplies were inadequate in places, especially for ships on the Atlantic. In an attempt to relieve the railroad congestion and to conserve fuel the Fuel Administrator issued on January 17 an order closing industrial plants east of the Mississippi, except shipyards, steel mills, metal-working plants having Government contracts, and all fuel-producing operations, for a total of 13 working days between that date and the end of March. Blast-furnace output was below capacity on account of lack of suitable coke most of the year, and in October the influenza epidemic crippled mining, manufacturing, and shipping operations, which were throughout the year more or less handicapped by insufficient and inexperienced workmen.

In view of the foregoing obstacles in the path of the iron industry the record of accomplishments seems all the more creditable. The total quantities of iron ore mined and shipped in 1918 showed respective decreases of 7.5 per cent and 4.7 per cent as compared with the output in 1917, but the stocks at mines were reduced to the extent of 23 per cent in order to compensate partly for the diminished ore supply. Naturally the Lake shipments in the spring were retarded by the heavy ice that followed the severe winter, and the total for the year fell off more than 1,600,000 tons, but in the period from April to October, inclusive, these shipments were speeded up and their total exceeded by more than 2,600,000 tons those for the corresponding period of 1917. Blast-furnace output was likewise forced into a record pace, so that the losses in production of the first three months were gradually retrieved and in the period from April to October the production of pig iron exceeded that of the corresponding periods in both 1917 and 1916, and furthermore the production of the last six months of 1918 exceeded that of any similar period.

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[1] The statistics in this chapter were compiled by Hubert W. Davis, except those of imports and exports, which were compiled by J. A. Dorsey, both of the United States Geological Survey.

The general iron and steel trade was, of course, controlled by and for a time entirely subordinated to national needs, which for 10 months showed a rapid increase. Domestic business was repressed and foreign trade was limited largely to the needs of the Governments of the Allied countries. The curtailment of iron and steel for nonwar activities was accomplished indirectly by governmental action through allocation of supplies, freight embargoes, priority regulations, and fuel control. Much progress was made in conservation of labor, tools, machinery, and materials in manufacturing through standardization of products and the elimination of many nonessential sizes and models. It is hoped that the results of this movement may be lasting and may establish permanent economies in many industries.

After the signing of the armistice, on November 11, 1918, the momentum reached by the iron and steel industry was slowly checked through the governmental policy of making gradual readjustments rather than of abruptly canceling all orders, which would have resulted in throwing out of employment large bodies of workmen.

Beginning in the spring of 1917 and continuing throughout the period of the war the United States Geological Survey made field explorations, surveys, and laboratory studies of deposits of ores of metals used in the manufacture of pig iron, ferroalloys, and steel, including manganese, chromium, tungsten, molybdenum, titanium, uranium, vanadium, zirconium, and iron. Twenty-one geologists besides several temporary assistants were engaged in this work during the seasons of 1917 and 1918. More than 2,500 deposits were examined in a total of 27 States, besides Cuba, Porto Rico, Santo Domingo, Costa Rica, and Panama. As soon as the examination of a group of deposits could be completed systematic field notes giving estimates of quantity of ore were sent to the Washington office of the United States Geological Survey for the information of the Shipping, War Industries, and War Trade boards or other Government organizations that were interested in ascertaining what domestic supplies were available for substitution for foreign ores. The data were promptly published in the form of press bulletins. Several longer bulletins have already been published by the Geological Survey and by the American Institute of Mining and Metallurgical Engineers, and others are now in preparation which describe the essential features of the economic geology of the deposits. In this work the Survey enjoyed the cooperation of the California State Council of Defense and the State geological surveys of Colorado, Georgia, Minnesota, Tennessee, and Virginia, the University of Nevada, the New Mexico State School of Mines, and the United States Bureau of Mines.

The preliminary field work in the Cuyuna district, carried on by the United States Geological Survey in cooperation with the Minnesota Geological Survey, having been completed, a bulletin on this district has been published by the State Survey [1] and two shorter papers have been published by the Federal Survey.[2] The Minnesota Geological Survey has also recently completed a preliminary examination of the lean magnetic iron ores in the eastern part of the Mesabi district and is preparing a bulletin for publication on this subject.

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[1] Harder, E. C., and Johnston, A. W., Preliminary report on the geology of east-central Minnesota, including the Cuyuna iron-ore district: Minnesota Geol. Survey Bull. 15, 1918, 178 pp.

[2] Harder, E. C., and Johnston, A. W., Notes on the geology and iron ores of the Cuyuna district, Minn. U. S. Geol. Survey Bull. 660-A, 26 pp., 1917. Harder, E. C., Our mineral supplies—Manganiferous iron ores: U. S. Geol. Survey Bull. 666-EE, 13 pp., 1917.

The University of Minnesota school of mines experiment station is cooperating with the United States Geological Survey in an investigation of the potassium content of iron ores.

As shown in other chapters of Mineral Resources there were large increases in the domestic production of manganese, chrome, tungsten, and other ores of this steel-hardening group, and as shown on pages 569–571 of this chapter there were large increases in the domestic production of the ferroalloys during the war. To war prices is doubtless due part of the stimulation for this increased production, but it is believed that the work of the Federal geologists and their associates did much to encourage miners to patriotic efforts to develop domestic deposits of war-important minerals.

Estimates by the Geological Survey of the production and shipments of iron ore in 1918 were released on February 7, 1919, and comparison of these figures with the final ones published in this report indicates that the estimates were respectively only 0.08 per cent and 0.2 per cent too high.

IRON ORE.

IRON ORE MINED AND SHIPPED IN 1918.

The iron ore mined in the United States in 1918, exclusive of that containing 5 per cent or more of manganese,[1] amounted to 69,658,278 gross tons, as compared with 75,288,851 gross tons mined in 1917, a decrease of 5,630,573 gross tons, or 7.5 per cent. Beneficiated ore, instead of crude ore mined, is included in these figures, if the ore is treated in any way. The quantity of iron ore shipped from the mines in the United States in 1918 amounted to 72,021,202 gross tons, valued at $244,368,147, as compared with 75,573,207 gross tons, valued at $238,260,444, shipped in 1917. This represents a decrease in quantity of 3,552,005 gross tons, or 4.7 per cent, and an increase in value of $6,107,703, or 2.6 per cent, as compared with shipments in 1917. The average price per ton at the mines for all grades of ore for the whole country in 1918 was $3.39, as compared with $3.15 in 1917. These quantities of ore, both mined and shipped, include the iron ore used for fluxing other metallic ores at smelters in the Western States, but the shipments do not include the iron ore sold for the manufacture of paint. The quantity of iron ore sold for the manufacture of paint in 1918 amounted to 8,959 tons, valued at $22,924, or $2.56 per ton, compared with 18,656 gross tons, valued at $56,859, or $3.05 a ton in 1917.

The ore reported as sold for fluxing other than in the manufacture of pig iron amounted to 81,774 gross tons, valued at $290,423, in 1918, as compared with 107,793 gross tons, valued at $374,441, in 1917. The domestic iron ore actually sold for the manufacture of pig iron amounted in 1918 to 71,939,428 gross tons, valued at $244,077,724, as compared with 75,465,414 gross tons, valued at $237,886,003, in 1917.

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[1] The production of manganiferous iron ore is stated in the chapter on manganese and manganiferous ores in Mineral Resources for 1918.

A graphic comparison of the annual production of iron ore and its derived metals since 1870 is afforded by the curves shown in figure 5. It must be borne in mind, however, that the figures for the three products are not strictly comparable, because considerable foreign iron ore and also some cinder, scale, and scrap enter into the production of domestic pig iron, and considerable quantities of scrap iron and steel, as well as cinder and scale, enter into the production of new steel.

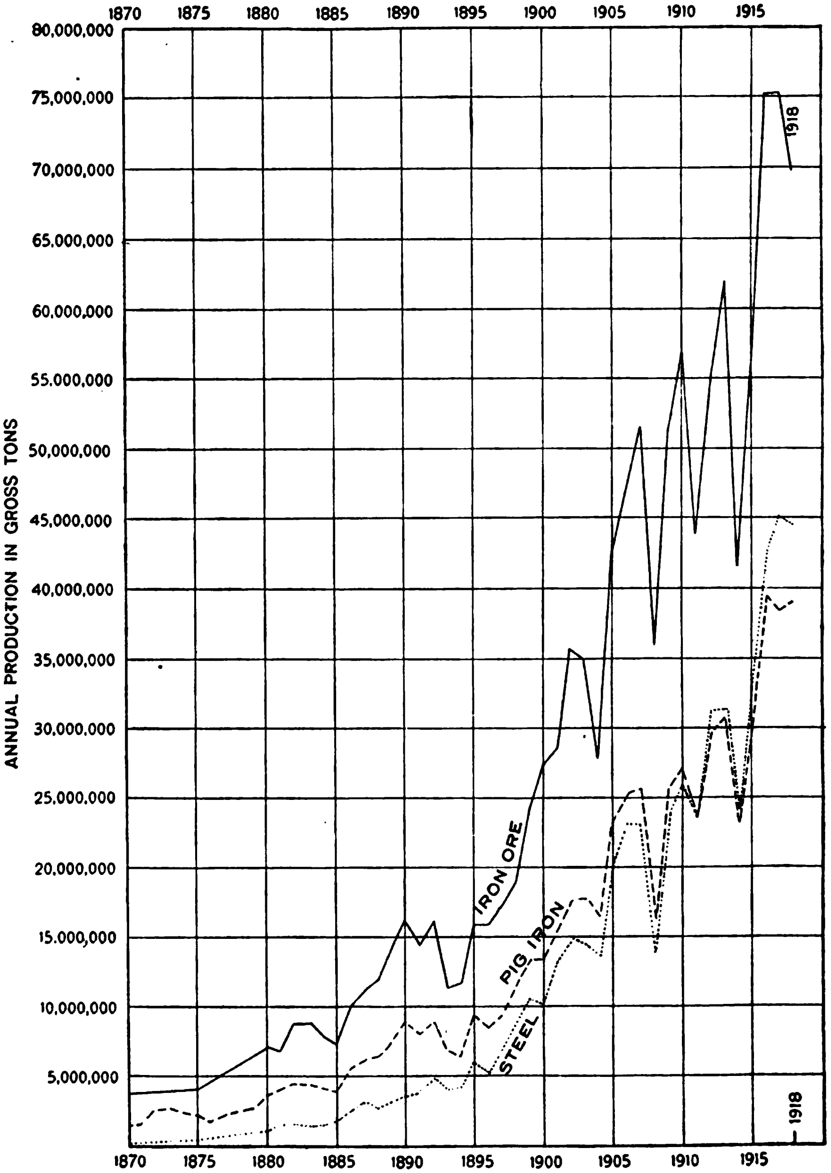

FIGURE 5.—Curves showing annual production of iron ore, pig iron, and steel in the United States, 1870-1918.

IRON ORE MINED AND SHIPPED, BY STATES.

Iron ore was mined in 26 States in 1918, as compared with 25 States in 1917, Arkansas and West Virginia having dropped out and Idaho, Texas, and Washington having been added as producers in 1918. Of these States California, Idaho, Montana, Nevada, Utah, and Washington produced iron ores for flux only; part of the production of Colorado and Michigan was used for smelter flux; a small quantity of ore from Virginia was used in the manufacture of hydrogen gas; the remaining States produced iron ore mainly for use in blast furnaces, except small quantities used for paint from Georgia, Michigan, New York, and Wisconsin. The rank of the three States producing the largest quantity of iron ore—Minnesota, Michigan, Alabama—remained practically unchanged in 1918. The Minnesota iron ranges are producing more iron ore than all the rest of the States together, having furnished about 60 per cent of the total for the United States in recent years.

IRON-ORE SHIPMENTS.

The following table, showing the iron ore shipped from the mines in 1917 and 1918, by States, is given precedence over the table showing the quantity mined because the table of shipments is the only one in which values are recorded:

Iron ore shipped from mines in the United States, 1917 and 1918, by States.

State.	1917		1918		Increase or decrease in 1918.		Percentage of increase or decrease in 1918.	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity.	Value.
Alabama	7,101,586	$13,049,535	6,121,087	$15,334,561	− 980,499	+$2,285,026	−13.8	+ 17.5
California	2,207	8,828	3,121	14,683	+ 914	+ 5,855	+41.4	+ 66.3
Georgia	211,501	524,175	262,003	878,612	+ 50,502	+ 354,437	+23.9	+ 67.6
Maryland	10,730	40,423	6,070	23,686	− 4,660	− 16,737	−43.4	− 41.4
Michigan	17,712,916	62,833,624	17,587,416	65,900,501	− 125,500	+3,066,877	− .7	+ 4.9
Minnesota	44,962,127	142,901,148	43,263,240	144,706,532	−1,698,887	+1,805,384	− 3.8	+ 1.3
Missouri	38,770	134,906	71,968	270,337	+ 33,198	+ 135,431	+85.6	+100.4
New Jersey	474,708	2,341,160	375,238	1,945,651	− 99,470	− 395,509	−21.0	− 16.9
New Mexico	231,604	381,275	275,266	546,212	+ 43,662	+ 164,937	+18.9	+ 43.3
New York	1,356,011	7,381,333	899,970	5,802,870	− 456,041	−1,578,463	−33.6	− 21.4
North Carolina	90,957	445,898	108,332	604,592	+ 17,375	+ 158,694	+19.1	+ 35.6
Pennsylvania	548,674	873,320	515,845	982,173	− 32,829	+ 108,853	− 6.0	+ 12.5
Tennessee	520,460	1,235,718	408,954	1,184,546	− 111,506	− 51,172	−21.4	− 4.1
Utah	(a)	(a)	52,722	168,438	(b)	(b)	(b)	(b)
Virginia	472,337	1,182,449	400,135	1,365,582	− 72,202	+ 183,133	−15.3	+ 15.5
Wisconsin	1,179,709	3,913,437	1,167,640	3,796,408	− 12,069	− 117,029	− 1.0	− 3.0
Other States [c]	658,910	1,013,215	502,195	842,763	−[b]103,993	− [b]2,014	−[b]15.8	− [b].2
	75,573,207	238,260,444	72,021,202	244,368,147	−3,552,005	+6,107,703	− 4.7	+ 2.6

[a] Less than three shippers in Utah in 1917 and permission not granted to publish State total. Figures for this State therefore included in "Other States."

[b] Increase for Utah included with those for "Other States."

[c] 1917: Arkansas, Colorado, Connecticut, Iowa, Massachusetts, Montana, Nevada, Utah, West Virginia, and Wyoming; 1918: Colorado, Connecticut, Idaho, Massachusetts, Montana, Nevada, Texas, Washington, and Wyoming.

IRON ORE MINED, BY VARIETIES, BY STATES, AND BY MINING DISTRICTS.

Iron minerals comprise sulphides, oxides, carbonates, silicates, and phosphates, of which only the oxides and the carbonates are used in the iron and steel industry, except a small quantity of oxide by-products from sulphide ores used in the manufacture of sulphuric acid. The ores of iron are generally classed under the four heads, hematite, brown ore, magnetite, and carbonate.[1]

Hematite has always been predominant as an ore of iron, and in 1918 it constituted nearly 95 per cent of the iron ore mined in the United States. Brown ore and magnetite are far below it in importance, having together furnished in 1918 a little more than 5 per cent of the total production of iron ore. The production of iron carbonate is insignificant in comparison with that of the other ores; in 1917 and 1918 none was reported to have been mined.

Iron ore mined in the United States in 1917 and 1918, by States and varieties, in gross tons, with percentage of increase or decrease in 1918.

State.	Hematite.	Brown ore..	Magnetite.	Total quantity.	Percentage of increase or decrease in 1918.
1917.					
Alabama	5,949,096	1,088,611		7,037,707	
Arkansas	40			40	
California			2,207	2,207	
Georgia	101,895	124,735		226,630	
Iowa		22,612		22,612	
Maryland	[a] 11,830	([a])		11,830	
Massachusetts		10,000		10,000	
Michigan	17,868,601			17,868,601	
Minnesota	44,595,232			44,595,232	
Missouri	26,866	12,042		38,908	
Nevada		1,010		1,010	
New Jersey			489,943	489,943	
New Mexico	25,471		211,750	237,221	
New York	[a] 53,514	([a])	1,250,803	1,304,317	
North Carolina		35,644	55,353	90,997	
Pennsylvania		4,927	541,773	546,700	
Tennessee	260,038	247,340	1,151	508,529	
Utah		48,058		48,058	
Virginia	109,166	360,711	26	469,903	
West Virginia		4,632		4,632	
Wisconsin	1,202,235			1,202,235	
Wyoming	543,846			543,846	
Other States [b]		27,693		27,693	
	70,743,513	1,992,332	2,553,006	75,288,851	
1918.					
Alabama	4,985,557	769,067		5,754,624	− 18.2
California			3,107	3,107	+ 40.8
Colorado		7,850		7,850	([c])
Connecticut		12,130		12,130	([c])
Georgia	114,720	149,882		264,602	+ 16.8
Idaho		785		785	
Iowa		7,052		7,052	− 68.8
Maryland	([d])	[d] 8,081		8,081	− 31.7
Massachusetts		8,450		8,450	− 15.5
Michigan	16,899,341			16,899,341	− 5.4
Minnesota	41,953,969			41,953,969	− 5.9
Missouri	56,755	15,953		72,708	+ 86.9
Montana		300	1,115	1,415	([c])
Nevada		20,303		20,303	+ 1,910.2
New Jersey			423,525	423,525	− 13.6
New Mexico	750		267,916	268,666	+ 13.3
New York	43,813		862,366	906,179	− 30.5
North Carolina		47,739	60,593	108,332	+ 19.1
Pennsylvania		3,163	519,437	522,600	− 4.4
Tennessee	220,849	188,105		408,954	− 19.6
Utah		42,556	10,166	52,722	+ 9.7
Virginia	81,120	332,928		414,048	− 11.9
Wisconsin	1,089,351			1,089,351	− 9.4
Wyoming	447,884			447,884	− 1.1
Other States [e]		100	1,500	1,600	− [c] 17.0
	65,894,709	1,613,844	2,149,725	69,658,278	− 7.5

[a] Brown ore included in hematite.
[b] Colorado, Connecticut, and Montana.
[c] Less than three producers in Colorado, Connecticut, and Montana in 1917, and permission not granted to publish State totals. Decreases in 1918, therefore, included in "Other States."
[d] Hematite included in brown ore.
[e] Texas and Washington.

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[1] Notes concerning the composition of these types of ores are given in U. S. Geol. Survey Mineral Resources, 1916, pt. 1, pp. 537-541, 1918.

Each of the principal iron-mining districts in the United States, except the Adirondack and Birmingham districts, lies in more than one State, and the different varieties of ore are to a large extent locally segregated, so that statistics of production by districts are of more general interest and importance than statistics by States. The Lake Superior district, comprising all the mines in Minnesota and Michigan and those in northern Wisconsin, mined 59,779,794 gross tons in 1918, nearly all hematite, compared with 63,481,321 gross tons in 1917, a decrease of 5.8 per cent. This district mined about 85 per cent of the total ore in 1917 and 1918. The Birmingham district, in north-central Alabama, mined 5,107,389 gross tons of ore, including both hematite and brown ore, in 1918, compared with 6,187,073 tons in 1917, a decrease of 17.5 per cent. This district therefore mined a little more than 7 per cent of the total, or a little less than one-twelfth as much as the Lake district in 1918. The Adirondack district, New York, mined 762,029 gross tons of magnetite in 1918, compared with 1,100,001 tons in 1917, a decrease of 30.7 per cent.

Iron ore [a] mined in the United States, by mining districts and varieties, in 1917 and 1918, in gross tons.

1917.

District.	Hematite.	Brown ore.	Magnetite.	Total.
Lake Superior [b]	63,481,321	....	....	63,481,321
Birmingham	5,728,862	458,211	....	6,187,073
Chattanooga	524,787	296,698	....	821,485
Adirondack	....	....	1,100,001	1,100,001
Northern New Jersey and southeastern New York	....	(c)	c 642,232	642,232
Other districts	1,008,543	1,235,936	812,260	3,056,739
	70,743,513	1,992,332	2,553,006	75,288,851

1918.

District.	Hematite.	Brown ore.	Magnetite.	Total.	Percentage of change in 1918.
Lake Superior [b]	59,779,794	....	....	59,779,794	−5.8
Birmingham	4,763,057	344,332	....	5,107,389	−17.5
Chattanooga	516,259	309,268	....	825,527	+.5
Adirondack	....	....	762,029	762,029	−30.7
Northern New Jersey and southeastern New York	....	....	523,862	523,862	−18.4
Other districts	835,599	960,244	863,834	2,659,677	−13.0
	65,894,709	1,613,844	2,149,725	69,658,278	−7.5

[a] Exclusive of ore containing 5 per cent or mere of manganese.
[b] Includes only those mines in Wisconsin which are in the true Lake Superior district.
[c] A small quantity of brown ore included in magnetite.

The Chattanooga district was the only large iron-ore producing district that showed an increase in output, as compared with 1917.

TOTAL OUTPUT OF IRON ORE.

The following table shows the production of various types of iron ore in the United States as far as it has been recorded or estimated. The statistics from 1889 to the present were collected by the United States Geological Survey; those for 1880 were collected for the census report of that year; those for 1881 were estimated by I. L. Bell;[1] and those from 1882 to 1888, inclusive, were estimated by James M. Swank[2] from the pig iron produced. Figures are not available for the production of various classes of iron ores prior to 1889, except for the census year 1880. The figures for the years prior to 1880 were calculated from the pig iron produced, which included imported ore as well as domestic ore used.

Iron ore mined in the United States, 1810–1918, in gross tons.

Year.	Hematite.	Brown ore.	Magnetite	Carbonate.	Total.
1810–1869					49,656,000
1870[a]–1879					44,570,527
1880	2,243,993	1,918,622	2,134,276	823,471	7,120,362
1881					7,119,643
1882					8,700,000
1883					8,800,000
1884					7,718,129
1885					7,600,000
1886					10,000,000
1887					11,300,000
1888					12,062,530
1889	9,056,288	2,523,087	2,506,415	432,251	14,518,041
1890	10,527,650	2,559,938	2,570,838	377,617	16,036,043
1891	9,327,398	2,757,564	2,317,108	189,108	14,591,178
1892	11,646,619	2,485,101	1,971,965	192,981	16,296,666
1893	8,272,637	1,849,272	1,330,886	134,834	11,587,629
1894	9,347,434	1,472,748	972,219	87,278	11,879,679
1895	12,513,995	2,102,358	1,268,222	73,039	15,957,614
1896	12,576,288	2,126,212	1,211,526	91,423	16,005,449
1897	14,413,318	1,961,954	1,059,479	83,295	17,518,046
1898	16,150,684	1,989,681	1,237,978	55,373	19,433,716
1899	20,004,399	2,869,785	1,727,430	81,559	24,683,173
1900	22,708,274	3,231,089	1,537,551	76,247	27,553,161
1901	24,006,025	3,016,715	1,813,076	51,663	28,887,479
1902	30,532,149	3,305,484	1,688,860	27,642	35,554,135
1903	30,328,654	3,080,399	1,575,422	34,833	35,019,308
1904	23,839,477	2,146,795	1,638,846	19,212	27,644,330
1905	37,567,055	2,546,662	2,390,417	21,999	42,526,133
1906	42,481,375	2,781,063	2,469,294	17,996	47,749,728
1907	46,060,486	2,957,477	2,679,067	23,589	51,720,619
1908	31,788,564	[b] 2,620,390	[b] 1,547,797	26,585	35,983,336
1909	46,208,640	[b] 2,839,265	[b] 2,229,839	16,527	51,294,271
1910	51,367,007	[b] 2,993,744	[b] 2,631,835	22,320	57,014,906
1911	39,626,224	2,032,094	2,202,527	15,707	43,876,552
1912	51,345,782	1,614,486	2,179,533	10,346	55,150,147
1913	57,933,251	1,682,063	2,357,274	7,849	61,980,437
1914	38,286,670	1,537,750	1,610,203	5,138	41,439,761
1915	52,227,324	1,488,709	1,807,002	3,455	55,526,490
1916	70,728,024	1,904,484	2,533,364	1,800	75,167,672
1917	70,743,513	1,992,332	2,553,006		75,288,851
1918	65,894,709	1,613,844	2,149,725		69.658,278
					1,272,190,019

[a] Includes ore produced by owners of blast furnaces, estimated by census at 800,000 tons.
[b] Some brown ore included in magnetite.

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[1] Principles of the manufacture of iron and steel, p. 451, 1884.

[2] U. S. Geol. Survey Mineral Resources, 1882 to 1888.

PRINCIPAL IRON-ORE MINES.

In 1918 there were 458 iron-ore mines active, compared with 452 in 1917, and 220 mines in 1918 produced more than 50,000 gross tons of iron ore each, compared with 240 mines in 1917. The total ore produced by the mines whose output was more than 50,000 gross tons each was 66,731,025 gross tons, or nearly 96 per cent of the entire production of the United States in 1918. Of these 220 mines 12 (1 more than in 1917) produced more than 1,000,000 tons of ore each in 1918. First place in 1918 was held by the Hull-Rust mine, at Hibbing, Minn.; second place by the Red Mountain group, near Bessemer, Ala.; third place by the Kerr, at Hibbing, Minn.; and fourth place by the Mahoning, at Hibbing, Minn. The production of these mines in 1918 was, respectively, 5,485,715 tons, 2,376,974 tons, 2,027,589 tons, and 2,024,675 tons, compared with 6,468,483 tons, 2,955,022 tons, 1,586,409 tons, and 2,525,145 tons, respectively, in 1917. Eight of the 12 mines producing more than 1,000,000 tons in 1918 are in Minnesota. The largest producer in Michigan in 1918 was the Norrie group, which reported having mined 1,204,698 gross tons of hematite, a decrease from the production in 1917. Permission has been granted to the Survey by the owners and operators of 198 of these large mines to publish their production, and these statistics are given in the following table:

Iron-ore mines of the United States that produced more than 50,000 gross tons each in 1918.

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity mined.
					Gross tons.
1	Hull-Rust	Minnesota	Hibbing	Hematite	5,485,715
2	Red Mountain group	Alabama	Bessemer	do	2,376,974
3	Kerr	Minnesota	Hibbing	do	2,027,589
4	Mahoning	do	do	do	2,024,675
5	Canisteo	do	Coleraine	do	1,426,465
6	Fayal	do	Eleveth	do	1,393,589
7	Norrie group	Michigan	Ironwood	do	1,204,698
8	Missabe Mountain	Minnesota	Virginia	do	1,173,311
9	Wakefield	Michigan	Wakefield	do	1,130,432
10	Adams	Minnesota	Eveleth	do	1,096,466
11	Morris	do	Hibbing	do	1,044,558
12	Newport and Bonnie	Michigan	Ironwood	do	1,002,243
13	Hartley-Burt	Minnesota	Chisholm	do	954,154
14	Bennett	do	Keewatin	do	892,823
15	Sellers	do	Hibbing	do	865,211
16	Plymouth	Michigan	Verona	do	821,867
17	Dean	Minnesota	Buhl	do	797,932
18	Burt	do	Hibbing	do	749,884
19	Holman	do	Taconite	do	736,551
20	Chapin	Michigan	Iron Mountain	do	735,950
21	Woodward Nos. 1, 2, and 3	Alabama	Lipscomb	do	718,237
22	Leonidas	Minnesota	Eveleth	do	664,605
23	Palms	Michigan	Bessemer	do	640,549
24	Dunwoody	Minnesota	Hibbing	do	623,555
25	Glen	do	Chisholm	do	618,751
26	Hawkins	do	Nashwauk	do	612,440
27	Spruce	do	Eveleth	do	577,565
28	Susquehanna	do	Hibbing	do	569,420
29	Hill Annex	do	Calumet	do	559,074
30	Witherbee, Sherman & Co. (Inc.).	New York	Mineville	Magnetite	557,665
31	Sauntry-Alpena	Minnesota	Virginia	Hematite	511,918
32	Sloss Nos. 1 and 2	Alabama	Bessemer	do	502,069
33	Albany	Minnesota	Hibbing	do	498,644
34	Biwabik	do	Biwabik	do	496,061
35	Cornwall	Pennsylvania	Miners Village	Magnetite	480,684
36	Shenango	Minnesota	Chisholm	Hematite	472,385
37	Sunrise	Wyoming	Sunrise	do	433,473
38	Corsica	Minnesota	Gilbert	do	389,747
39	North Harrison	do	Nashwauk	do	375,934
40	Caspian	Michigan	Palatka	do	359,826

Iron-ore mines of the United States that produced more than 50,000 gross tons each in 1918—Continued.

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity mined.
					Gross tons.
41	Penn group	Michigan	Norway and Vulcan.	Hematite	352,947
42	Colby	do	Bessemer	do	342,000
43	Miller	Minnesota	Aurora	do	337,100
44	Chester	do	Chisholm	do	331,954
45	Chisholm	do	do	do	326,097
46	Stevenson	do	Hibbing	do	323,500
47	Carpenter	Michigan	Crystal Falls	do	322,487
48	Montreal	Wisconsin	Montreal	do	302,989
49	Aragon	Michigan	Norway	do	296,426
50	Arcturus	Minnesota	Marble	do	295,546
51	La Rue	do	Nashwauk	do	295,465
52	Utica	do	Hibbing	do	294,191
53	Commodore	do	Virginia	do	288,973
54	Lake Superior	Michigan	Ishpeming	do	288,133
55	Leonard	Minnesota	Chisholm	do	287,418
56	Lincoln	do	Virginia	do	286,870
57	Leetonia	do	Hibbing	do	281,043
58	Aurora	Michigan	Ironwood	do	278,847
59	Bengal	do	Palatka	do	274,878
60	Pioneer	Minnesota	Ely	do	273,633
61	Bristol	Michigan	Crystal Falls	do	263,700
62	Ottowa	Wisconsin	Montreal	do	254,578
63	Alexandria	Minnesota	Chisholm	do	253,000
64	Majorca	do	Calumet	do	251,707
65	Balkan	Michigan	Alpha	do	247,829
66	Mace, No. 2	Minnesota	Nashwauk	do	247,590
67	Saint James	do	Aurora	do	243,309
68	Songo	Alabama	Songo	do	242,549
69	Zenith	Minnesota	Ely	do	239,028
70	Odgers	Michigan	Crystal Falls	do	239,000
71	Mohawk	Minnesota	Aurora	do	233,186
72	Pettit	do	Gilbert	do	232,179
73	Patrick	do	Nashwauk	do	227,894
74	Cary	Wisconsin	Hurley	do	227,468
75	Union	Minnesota	Virginia	do	226,606
76	Tully	Michigan	Stambaugh	do	219,230
77	Russellville	Alabama	Russellville	Brown ore	216,611
78	Armour No. 2	Minnesota	Crosby	Hematite	209,824
79	Kinney	do	Kinney	do	203,542
80	Kennedy	do	Cuyuna	do	203,403
81	Chatham	Michigan	Stambaugh	do	201,069
82	Clark	Minnesota	Chisholm	do	198,154
83	Belgrade	do	Biwabik	do	195,427
84	Warren	do	Hibbing	do	195,007
85	Osana-Wauseca	Michigan	Iron River	do	193,981
86	Philbin	Minnesota	Hibbing	do	191,517
87	Brunt	do	Mountain Iron	do	189,089
88	Eureka	Michigan	Ramsay	do	187,412
89	Puritan	do	Ironwood	do	182,527
90	Wanless	Minnesota	Buhl	do	182,009
91	Genoa	do	Gilbert	do	181,224
92	Ironton	Michigan	Bessemer	do	180,000
93	Wacootah	Minnesota	Mountain Iron	do	173,395
94	Woodbridge	do	Buhl	do	170,030
95	Frantz	do	do	do	169,640
96	Spaulding	Alabama	Birmingham	do	168,195
97	Pennington	Minnesota	Ironton	do	164,715
98	Zimmerman	Michigan	Gaastra	do	161,993
99	Sibley	Minnesota	Ely	do	155,626
100	North Anvil	Michigan	Bessemer	do	154,663
101	Homer	do	Iron River	do	153,693
102	State Lease 40	Minnesota	Crosby	do	152,976
103	Webb	do	Hibbing	do	152,743
104	Union Hill	New Mexico	Fierro	Magnetite	152,010
105	Meacham	Minnesota	Crosby	Hematite	151,725
106	Cambria	Michigan	Negaunee	do	148,877
107	Sunday Lake	do	Wakefield	do	144,938
108	Thompson	Minnesota	Crosby	do	143,870
109	Richmond	Michigan	Palmer	do	142,638
110	Croft	Minnesota	Crosby	do	141,790
111	Soudan	do	Soudan	do	140,707
112	Chandler	do	Ely	do	139,179
113	Tobin	Michigan	Crystal Falls	do	137,800
114	Judson	do	Alpha	do	135,273
115	Loretto	do	Loretto	do	132,644
116	Mount Hope	New Jersey	Mount Hope	Magnetite	132,292
117	Bray	Minnesota	Keewatin	Hematite	129,490

Iron-ore mines of the United States that produced more than 50,000 gross tons each in 1918—Continued.

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity mined.
					Gross tons.
118	Raimund No. 1	Alabama	Bessemer	Hematite	128,379
119	Laura	Minnesota	Hibbing	do	128,325
120	Section 30	do	Ely	do	125,204
121	North Eddy	do	Hibbing	do	124,649
122	Mississippi	do	Keewatin	do	124,392
123	Washington	New Jersey	Oxford Furnace	Magnetite	123,653
124	Shiras	Minnesota	Buhl	Hematite	123,348
125	Grant	do	do	do	122,973
126	York	do	Nashwauk	do	122,833
127	Julia	do	Virginia	do	122,079
128	Asteroid	Michigan	Ramsay	do	121,749
129	Yale	do	Bessemer	do	121,556
130	Fault	Minnesota	Eveleth	do	120,485
131	Clifford	Michigan	Iron Mountain	do	119,182
132	Hillcrest	Minnesota	Ironton	do	118,808
133	Hammond	Alabama	Hammond	do	118,464
134	Brown Mining Co.	Tennessee	Cardiff	do	116,601
135	Tilden	Michigan	Bessemer	do	116,496
136	Riverton group	do	Iron River	do	114,751
137	Geneva	do	Ironwood	do	114,472
138	Greeley	Alabama	Greeley	Brown ore	113,203
139	South Uno (N. P.)	Minnesota	Hibbing	Hematite	112,833
140	South Chandler	do	Ely	do	111,826
141	Bangor	do	Biwabik	do	110,826
142	Steinman	Alabama	Steinman	do	109,222
143	American-Boston	Michigan	Diorite	do	107,369
144	Irondale	Alabama	Irondale	do	106,074
145	Itasca	Minnesota	Buhl	do	104,858
146	Agnew	do	Hibbing	do	103,897
147	Ernst	Wisconsin	Commonwealth	do	103,417
148	Attalla No. 1	Alabama	Attalla	do	102,938
149	Armour No. 1	Minnesota	Crosby	do	101,937
150	Bates	Michigan	Iron River	do	101,264
151	Mary Charlotte, Nos. 1 and 2	do	Negaunee	do	100,572
152	Ordean	Minnesota	Virginia	do	100,517
153	Sliver	do	do	do	99,624
154	Hiawatha	Michigan	Iron River	do	97,214
155	Morrow	Minnesota	Eveleth	do	96,317
156	Richards	Michigan	Crystal Falls	do	95,300
157	Townsite	do	Ironwood	do	95,097
158	Raimund No. 2	Alabama	Bessemer	do	94,347
159	Isabella	Michigan	Palmer	do	93,595
160	Burns	Minnesota	Eveleth	do	92,865
161	Estelle	Georgia	Estelle	do	91,702
162	Breitung-Hematite No. 1	Michigan	Negaunee	do	90,073
163	Tioga	Minnesota	Chisholm	do	90,018
164	Baltic (including Fogarty)	Michigan	Palatka	do	89,875
165	Chicagon	do	Iron River	do	89,097
166	Elba	Minnesota	Gilbert	do	88,890
167	Mayville	Wisconsin	Mayville	do	88,771
168	Davidson No. 1	Michigan	Iron River	do	87,099
169	Warner	do	Amasa	do	83,845
170	Cuyuna-Duluth	Minnesota	Ironton	do	80,440
171	Davidson No. 2	Michigan	Iron River	do	76,784
172	Rogers	do	do	do	75,996
173	Norman	Minnesota	Virginia	do	74,353
174	Cahoon	Wisconsin	Baraboo	do	73,000
175	Castile	Michigan	Wakefield	do	72,700
176	La Belle	Minnesota	Gilbert	do	71,443
177	Amasa Porter	Michigan	Amasa	do	69,579
178	Pearson	Minnesota	Nashwauk	do	68,630
179	Hudson	do	Aurora	do	68,129
180	Mace No. 1	do	Hibbing	do	67,342
181	Victoria	do	Virginia	do	65,977
182	North Uno (N. P.)	do	Hibbing	do	63,257
183	Oriskany	Virginia	Oriskany	Brown ore	62,500
184	Jim Fair	New Mexico	Fierro	Magnetite	61,103
185	Deacon	Minnesota	Buhl	Hematite	60,668
186	Cranberry	North Carolina	Cranberry	Magnetite	60,326
187	Indiana	Michigan	Iron Mountain	Hematite	59,259
188	Quinn	Minnesota	Nashwauk	do	59,019
189	Ironaton	Alabama	Ironaton	Brown ore	57,530
190	Grace	Minnesota	Hibbing	Hematite	56,894
191	Thorne	do	Buhl	do	56,059
192	Brotherton	Michigan	Wakefield	do	55,947
193	Munro	do	Norway	do	53,031
194	Mahnomen	Minnesota	Ironton	do	53,000

Iron-ore mines of the United States that produced more than 50,000 gross tons each in 1918—Continued.

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity mined.
					Gross tons.
195	Ashland	Michigan	Ironwood	Hematite	51,226
196	Perkins	Minnesota	Aurora	do	50,807
197	Pewabic	Michigan	Iron Mountain	do	50,384
198	Adams	do	Ishpeming	do	50,211
Total (198 mines)					62,803,212
Unspecified (22 mines)[a]					3,927,813
Output from mines producing more than 50,000 gross tons each					66,731,025
Output from mines producing less than 50,000 gross tons each					2,927,253
Grand total of United States					69,658,278

[a] Includes the product of 22 mines producing more than 50,000 gross tons each and operated by 7 companies which do not permit the publication of individual figures.

STOCK OF IRON ORE AT MINES.

According to the reports of producers, a few of which have been revised since the report for 1917 was published, the total quantity of iron ore in stock at the mines at the end of 1918 amounted to 8,471,507 gross tons, compared with 11,003,843 tons at the close of 1917, a decrease of about 23 per cent. As the quantity of ore in stock piles is necessarily partly estimated, there are variations in the mine reports from year to year which prevent an absolute balance between the quantity mined and the quantity sold and stocks on hand.

Stock of iron ore at mines, by States, Dec. 31, 1917 and 1918, in gross tons.

State.	1917	1918	State.	1917	1918
Alabama	617,222	242,781	New Mexico	7,700	1,100
California	14		New York	61,647	35,049
Georgia	20,654	20,025	North Carolina	40	40
Iowa	5,113	12,165	Ohio	3,388	3,388
Maryland	2,130	4,141	Pennsylvania	34,961	41,593
Massachusetts	2,950	1,172	Virginia	30,613	44,527
Michigan	4,946,986	4,258,920	Wisconsin	310,557	232,250
Minnesota	4,802,634	3,365,540			
Missouri	2,320	3,060		11,003,843	8,471,507
New Jersey	154,914	205,756			

PRICES OF IRON ORE PER TON.

In the following table the average selling price per ton at the mines of the different classes of iron ore in 1917 and 1918 is given for each of the producing States or groups of States, except where there were less than three producers or shippers of a certain variety of ore in a State, and permission was not given to publish the prices. The average prices per gross ton (the whole United States considered) in 1918 were: Hematite, $3.35; brown ore, $3.51; and magnetite, $4.60; as compared with prices, respectively, of $3.12, $2.95, and $4.29, in 1917. These figures are taken directly from statements of the producers and probably represent only approximately the actual selling prices. By far the greater bulk of the iron ore produced in the United States is mined by iron and steel producers for their own furnaces and the value placed on such ore is therefore largely a matter of accounting. Some of the reports made to the Survey evidently include merely actual mining costs; others contain, in addition, the cost of selling and insuring the ore; in others an allowance for sinking fund is included; and in still others the figures given are the prices used in charging costs against the blast furnaces. At any rate, they include no freight costs. The selling prices of Lake Superior iron ore at lower Lake ports are given on pages 548-549.

The general average price per gross ton of all kinds of iron ore in the United States was $3.39 in 1918, compared with $3.15 in 1917, an increase of 24 cents a ton, or 7.6 per cent.

Average price per gross ton of iron ore in the United States in 1917 and 1918.

State.	Hematite.		Brown ore.		Magnetite.	
	1917	1918	1917	1918	1917	1918
Alabama	$1.61	$2.36	$3.08	$3.55		
California					$4.00	$4.70
Georgia	2.36	2.59	2.58	3.92		
Maryland	(a)	(a)	2.56	3.67		
Michigan	3.55	3.75				
Minnesota	3.18	3.34				
Missouri	3.98	3.84	2.27	3.46		
New Jersey					4.93	5.19
New Mexico	2.27	(a)			1.57	1.98
New York	(a)	(a)	(a)		5.53	6.60
North Carolina			2.42	3.26	(a)	(a)
Pennsylvania			4.20	(a)	(a)	(a)
Tennessee	1.76	2.43	3.01	3.44	(a)	
Utah			(a)	3.03		(a)
Virginia	2.54	3.84	2.49	3.30	(a)	
Wisconsin	3.32	3.25				
Other States [b]	1.11	1.40	3.54	3.92		1.91
Total average	3.12	3.35	2.95	3.51	4.29	4.60

[a] Less than three producers and permission to publish not given; therefore price may not be shown.

[b] 1917: Arkansas, Colorado, Connecticut, Iowa, Massachusetts, Montana, Nevada, Utah, West Virginia, and Wyoming. 1918: Colorado, Connecticut, Idaho, Massachusetts, Montana, Nevada, Pennsylvania, Texas, Washington, and Wyoming.

Average price per gross ton of iron ore in the United States, 1889, 1892-1918.

Year.	Hematite.	Brown ore.	Magnetite.	Carbonate.	General average.
1889					$2.30
1892					2.04
1893					1.66
1894					1.14
1895					1.14
1896					1.42
1897					1.08
1898					1.14
1899					1.42
1900					2.42
1901					1.71
1902					1.84
1903					1.89
1904					1.56
1905					1.77
1906	$2.13	$1.78	$2.05	$1.75	2.11
1907	2.03	1.81	2.03	1.74	2.55
1908	2.32	1.70	2.40	1.38	2.27
1909	2.17	1.68	2.40	1.73	2.15
1910	2.52	1.76	2.36	1.61	2.47
1911	2.12	1.72	2.29	1.83	2.11
1912	1.87	1.79	2.18	1.96	1.88
1913	2.21	1.88	2.07	2.06	2.19
1914	1.79	1.72	2.39	2.44	1.81
1915	1.80	1.80	2.50	2.44	1.83
1916	2.32	2.03	3.11	3.00	2.34
1917	3.12	2.95	4.29		3.15
1918	3.35	3.51	4.60		3.39

APPARENT CONSUMPTION OF IRON ORE COMPARED WITH PRODUCTION OF PIG IRON AND FERROALLOYS.

The following table includes data on certain items from which an approximate estimate of the annual consumption of iron ore in the United States is deduced. The result is, of course, merely an approximation, for no data are available on certain items, such as stocks at furnaces, which should enter into the final result. The items considered in the table and in the annual estimates for all years preceding 1911 are (1) domestic iron ore mined; (2) stocks of ore at mines; (3) stocks of ore at lower Lake ports; (4) production of zinc residuum; (5) imports of ore; (6) exports of ore. Beginning with 1911 data on the shipments of ore have been collected by the Geological Survey, and these figures, together with zinc residuum and imports of ore, constitute the available supply which, less the exports, give the apparent domestic consumption, without consideration of the stocks at mines and at Lake ports. This apparent consumption includes small quantities of ore not used in the manufacture of pig iron, such as ore consumed in the open-hearth steel furnaces and in smelting gold, silver, and copper; but it does not include ore used in the manufacture of paint.

In the same table is given the production of pig iron, including ferromanganese, spiegeleisen, ferrosilicon, and other ferroalloys, for corresponding years and the ratio of pig iron and ferroalloys produced to iron ore consumed. On later pages of the report will be found detailed statistics on the production and shipments of pig iron.

The ratio of pig iron manufactured to iron ore consumed was 54.47 per cent in 1918, as compared with 51.11 per cent in 1917.

Apparent consumption of iron ore compared with production of pig iron and ferroalloys in the United States, 1889–1918, in gross tons.

Year.	Domestic iron ore produced.[a]	Stocks of ore at mines.	Stocks of ore at lower Lake ports Dec. 1.	Zinc residuum.	Imports.	Exports.	Apparent consumption.	Pig iron produced.[b]	Percentage ratio of pig iron to iron ore.
1889	14,518,041	2,256,973	2,607,106	43,648	853,573	....	14,366,562	7,603,642	52.93
1890	16,036,043	2,000,000	3,893,487	48,560	1,246,830	....	16,302,025	9,202,703	56.45
1891	14,591,178	2,450,279	3,508,489	38,228	912,864	....	15,476,989	8,279,870	53.50
1892	16,296,666	2,911,740	4,149,451	31,859	806,585	....	16,032,687	9,157,000	57.11
1893	11,587,629	3.526,161	4,070,710	37,512	526,951	....	11,616,412	7,124,502	61.33
1894	11,879,679	3,236,198	4,834,247	26,981	167,307	....	11,600,393	6,657,388	57.39
1895	15,957,614	2.976,494	4,415,712	43,249	524,153	....	17,203,255	9,446,308	54.91
1896	16,005,449	3,405,302	4,954,984	44,953	682,806	....	15,765,128	8,623,127	54.70
1897	17,518,046	3,098,287	5,923,755	33,924	489,970	....	17,380,184	9,652,680	55.54
1898	19,433,716	2,846,457	5,136,407	48,502	187,208	....	20,708,604	11,773,934	56.86
1899	24,683,173	2,320,278	5,530,283	65,010	674,082	40,665	25,513,903	13,620,703	53.39
1900	27,553,161	3,709,950	5,904,670	87,110	897,831	51,460	26,722,583	13,789,242	51.60
1901	28,887,479	4,239,823	5,859,663	52,311	966,950	64,703	29,357,171	15,878,354	54.09
1902	35,554,135	3,834,717	7,074,254	65,246	1,165,470	88,445	35,886,921	17,821,307	49.66
1903	35,019,308	6,297,888	6,371,085	73,264	980,440	80,611	34,232,399	18,009,252	52.61
1904	27,644,330	4,666,931	5,763,399	68,189	487,613	213,865	30,224,910	16,497,033	54.58
1905	42,526,133	3,812,281	6,438,967	90,289	845,651	208,017	43,433,138	22,992,380	52.94
1906	47,749,728	3,281,789	6,252,455	93,461	1,060,390	265,240	49,355,343	25,307,191	51.28
1907	51,720,619	3,033,110	7,385,728	93,413	1,229,168	278,608	51,879,998	25,781,361	49.69
1908	35,983,336	6.065,397	8,441,533	110,225	776,898	309,099	32.473,268	15,936,018	49.74
1909	51,294,271	6,135,271	8,965,789	141,264	1,694,957	455,934	52,080,428	25,795,471	49.53
1910	57,014,906	9,422,285	9,426,881	137,173	2,591,031	748,875	55,246,129	27,303,567	49.42
1911	41,092,447	....	....	109,296	1,811,732	768,386	42,245,089	23,649,547	55.98
1912	57,017,614	....	....	104,670	2,104,576	1,195,742	58,031,118	29,726,937	51.23
1913	59,643,098	....	....	102,239	2,594,770	1,042,151	61,297,956	30,966,152	50.52
1914	39,714,280	....	....	100,198	1,350,588	551,618	40,613,448	23,332,244	57.45
1915	55.493,100	....	....	159,318	1,341,281	707,641	56.286,058	29,916,213	53.15
1916	77,870,553	....	....	198,817	1,325.736	1,183,952	78,211,154	39,434,797	50.42
1917	75,573,207	....	....	155,332	971,663	1,132,313	75,567,889	38,621,216	51.11
1918	72,021,202	....	....	146,796	787,468	1,256,383	71,699,083	39,054,644	54,47

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[a] Beginning with 1911, figures represent shipments from mines. Beginning with 1910, iron ore sold for paint excluded from production and included in metallic paint.

[b] From annual reports of the American Iron and Steel Association prior to 1912, and including ferroalloys produced in blast furnaces; beginning with 1912, according to American Iron and Steel Institute, and also including ferroalloys.

The actual figures of consumption of ore as reported directly to the Survey by the manufacturers of iron are of interest in comparison with the figures in this table. Prior to 1915 such data have not been sufficiently complete for publication, but in connection with the statistics of value of pig iron, which are collected only by the United States Geological Survey, it has been found necessary to gather related data, some of which are now sufficiently complete for publication. For instance, the quantity of domestic ore consumed in the manufacture of pig iron in 1918, according to reports to the Survey from blast furnaces, was 69,905,547 gross tons; the total consumption of iron ore in 1918, including imported ore and 5,343,963 tons of mill cinder, scale, and scrap, was 75,939,655 gross tons, from which were produced 38,130,786 gross tons of pig iron, exclusive of ferroalloys—a ratio of pig iron produced to ore consumed of 50.21 per cent. The quantity of pig iron made in 1918 from domestic ore was 37,679,786 gross tons and from foreign ore 451,000 gross tons. In 1917 the domestic ore consumed was 69,108,181 gross tons, and the total consumption of iron ore, including imported ore and 5,647,723 tons of mill cinder, scale, and scrap, was 75,505,078 gross tons, from which were produced 37,924,490 gross tons of pig iron, exclusive of ferroalloys—a ratio of pig iron produced to ore consumed of 50.22 per cent. Such of these figures as are available for the years 1915–1918 are shown in the following table.

Iron ore and accessory materials consumed in manufacture of pig iron, 1915–1918.

Year.	Metalliferous materials consumed (gross tons).				Pig iron produced exclusive of ferroalloys (gross tons).			Percentage ratio of pig iron to materials consumed.		
	Iron ore.		Miscellaneous[a] domestic and foreign.	Total.	From domestic materials.	From foreign materials.	Total.	Domestic.	Foreign.	Total.
	Domestic.	Foreign.								
1915	53,775,945	1,381,481	251,593	55,409,022	28,646,349	910,595	29,556,944	53.02	65.91	53.34
1916	70,769,337	1,295,518	4,036,022	76,100,877	37,974,413	727,550	38,701,963	50.76	56.16	50.86
1917	69,108,181	749,174	5,647,723	75,505,078	37,437,929	486,561	37,924,490	50.19	53.31	50.22
1918	69,905,547	690,145	5,343,963	75,939,655	37,679,786	451,000	38,130,786	50.13	57.86	50.21

[a] Pyrite cinder, scrap, mill cinder, and scale.

The following tabulation of consumption of iron ore and other metallic materials and of production of pig iron by States indicates in a very general way the yield in iron of ores from various districts. In the Southern States, for instance, especially in Alabama, Georgia, and Tennessee, local ores are used for the most part. According to the following figures the ratio of pig iron to metallic raw materials used is 39.6 per cent in Alabama, 42.4 per cent in Georgia, and 41.4 per cent in Tennessee. Virginia used considerable ore from the Lake Superior district as well as considerable mill cinder, and the ratio is higher. Colorado, using ores from the Rocky Mountain States, shows a ratio of 47.6 per cent. New York uses Lake Superior ores, local magnetite, and local hematite, besides mill cinder, and the reported yield of pig iron is 48.1 per cent, or about what might be expected. New Jersey uses magnetite from local mines and from New York and the ratio is fairly high.

The group of States in which Lake Superior ores (domestic and Canadian) were used, including Illinois, Indiana, Minnesota, Wisconsin, Michigan, Ohio, Kentucky, Pennsylvania, and West Virginia, with the exception of Indiana, all show ratios of more than 50 per cent. Maryland furnaces, consuming Cuban ores (see p. 553) show a yield of 58.4 per cent of iron. The pig iron produced in Connecticut and Massachusetts was derived from local ores and shows ratios of 45.7 per cent and 43.1 per cent, respectively. The pig iron produced in Missouri was derived in part from local ore, in part from nodulized limonite from Iowa, and in part from ore from the Lake Superior district, and the ratio shown is 50.6 per cent. In Washington a considerable proportion of ore from British Columbia was used and the mill cinder and scrap amounted to nearly twice the quantity of iron ore consumed, which accounts for the high ratio, 63.1 per cent, for this State.

It must borne in mind that the mill cinder, scale, and scrap consumed tend to increase the percentage of pig iron produced. So far as the records show, three States, Connecticut, Georgia, and Massachusetts, used none of these materials in the blast furnaces, but in all the others more or less was used, ranging from 2.4 per cent of the metallic raw materials in Michigan to 64.7 per cent in Washington.

Iron ore and other metallic materials consumed and pig iron produced, by States, in 1918.

State.	Material consumed (gross tons).			Pig iron produced (gross tons).	Ratio of pig iron to iron ore, cinder, scale, and scrap, (per cent).	Material consumed per ton of iron made (gross tons).		Percentages of material consumed.	
	Iron ore, domestic and foreign.	Cinder, scale, and scrap.	Total.			Ore.	Cinder, scale, and scrap.	Ore.	Cinder, scale, and scrap.
Alabama	6,125,761	303,570	6,429,331	2,546,289	39.604	2.406	.119	95.3	4.7
Colorado	744,007	23,053	767,060	365,178	47.607	2.037	.063	97.0	3.0
Connecticut	15,479	....	15,479	7,076	45.713	2.188	....	100.0	....
Georgia	1,700	....	1,700	720	42.353	2.361	....	100.0	....
Illinois	6,370,388	333,756	6,704,144	3,414,362	50.929	1.866	.098	95.0	5.0
Indiana	4,829,051	506,421	5,335,472	2,584,071	48.432	1.869	.196	90.5	9.5
Kentucky	388,018	51,623	439,641	227,731	51.799	1.701	.227	88.3	11.7
Maryland	559,788	67,693	627,481	366,461	58.402	1.528	.185	89.2	10.8
Massachusetts	10,228	....	10,228	4,409	43.107	2.320	....	100.0	....
Michigan	916,407	22,420	938,827	489,816	52.173	1.871	.046	97.6	2.4
Minnesota	681,365	83,755	765,120	385,756	50.418	1.766	.217	89.1	10.9
Missouri	138,064	26,703	164,767	83,430	50.635	1.655	.320	83.8	16.2
New Jersey	413,814	18,702	432,516	228,024	52.720	1.815	.082	95.7	4.3
New York	5,079,240	138,204	5,217,444	2,507,854	48.067	2.025	.055	97.4	2.6
Ohio	15,756,859	1,037,628	16,794,487	8,688,114	51.732	1.814	.119	93.8	6.2
Pennsylvania	25,855,317	2,394,355	28,249,672	14,731,486	52.147	1.755	.163	91.5	8.5
Tennessee	741,619	57,719	799,338	331,265	41.442	2.239	.174	92.8	7.2
Virginia	729,063	191,537	920,600	445,105	48.349	1.638	.430	79.2	20.8
Washington	9,177	16,790	25,967	16,393	63.130	.560	1.021	35.3	64.7
West Virginia	610,114	15,716	625,830	342,573	54.739	1.781	.016	97.5	2.5
Wisconsin	620,233	54,318	674,551	364,670	54.061	1.701	.149	91.9	8.1
	70,595,692	5,343,963	75,939,655	38,130,786	50.212	1.851	.140	93.0	7.0

IRON ORE INDUSTRY IN THE LAKE SUPERIOR DISTRICT.

PRODUCTION.

The ranges in the United States portion of the Lake Superior district which produced ore in 1918 were the Marquette, Menominee, Gogebic, Vermilion, Mesabi, and Cuyuna, besides the Baraboo and Iron Ridge areas. The output of the Cuyuna range, as in 1917, surpassed that of the Vermilion range.

The total quantity of ore mined from the Lake Superior district, excluding the Baraboo and Iron Ridge areas, in 1918, was 59,779,794 gross tons, compared with 63,481,321 gross tons in 1917, a decrease of 3,701,527 tons, or 5.8 per cent. The output excludes all ore containing more than 5 per cent manganese. The Mesabi range mined 39,055,977 tons, compared with 41,127,323 tons in 1917, a decrease of 5 per cent; the Menominee range, 6,041,637 tons, compared with 6,366,483 tons in 1917, a decrease of 5.1 per cent; the Gogebic range, 7,837,634 tons, compared with 7,881,232 tons in 1917, a decrease of 0.6 per cent; the Marquette range, 3,946,554 tons, compared with 4,638,374 tons in 1917, a decrease of 14.9 per cent; the Vermilion range, 1,192,677 tons, compared with 1,481,301 tons in 1917, a decrease of 19.5 per cent; and the Cuyuna range, 1,705,315 tons, compared with 1,986,608 tons in 1917, a decrease of 14.2 per cent. The production of manganiferous iron ore from the Cuyuna range is reported in the chapter on manganese and manganiferous ores elsewhere in Mineral Resources for 1918. The Mesabi range produced 65.3 per cent of the entire output of the Lake Superior district and 56.1 per cent of the entire production of the United States.

Iron ore mined in the Lake Superior district,[a] *1917 and 1918, in gross tons.*

Range.	1917	1918	Decrease in 1918.	Percentage of decrease 1918.	Percentage of total output, 1918.	
					Lake Superior district.	United States.
Marquette (Michigan)	4,638,374	3,946,554	691,820	14.9	6.6	5.7
Menominee (Michigan and Wisconsin)	6,366,483	6,041,637	324,846	5.1	10.1	8.7
Gogebic (Michigan and Wisconsin)	7,881,232	7,837,634	43,598	.6	13.1	11.2
Vermilion (Minnesota)	1,481,301	1,192,677	288,624	19.5	2.0	1.7
Mesabi (Minnesota)	41,127,323	39,055,977	2,071,346	5.0	65.3	56.1
Cuyuna (Minnesota)	1,986,608	1,705,315	281,293	14.2	2.9	2.4
	63,481,321	59,779,794	3,701,527	5.8	100.0	85.8

[a] Includes only such Wisconsin mines as are in the true Lake Superior district.

The following table shows the total production of the Lake Superior district, by ranges. The figures prior to 1872 were collected by A. P. Swineford, editor Marquette Mining Journal;[1] those for 1872 to 1877, inclusive, are from the Michigan Mineral Statistics; those for 1878 to 1888, inclusive, were collected by W. J. Stevens;[2] and the later figures were collected by the United States Geological Survey.

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[1] U. S. Geol. Survey Mineral Resources, 1882, p. 116, 1883.

[2] Idem, 1891, pp. 39-41, 1893.

Iron ore produced in the Lake Superior district, 1854–1918, in gross tons.

Year.	Marquette.	Menominee.	Gogebic.	Vermilion.	Mesabi.	Cuyuna.	Total.
1854-1869	3,112,209	....	....	....	....	....	3,112,209
1870	859,507	....	....	....	....	....	859,507
1871	813,984	....	....	....	....	....	813,984
1872	948,553	....	....	....	....	....	948,553
1873	1,195,234	....	....	....	....	....	1,195,234
1874	899,934	....	....	....	....	....	899,934
1875	881,166	....	....	....	....	....	881,166
1876	993,311	....	....	....	....	....	993,311
1877	1,014,754	10,375	....	....	....	....	1,025,129
1878	1,033,082	78,028	....	....	....	....	1,111,110
1879	1,130,019	245,672	....	....	....	....	1,375,691
1880	1,384,010	524,735	....	....	....	....	1,908,745
1881	1,579,834	726,671	....	....	....	....	2,306,505
1882	1,829,394	1,136,018	....	....	....	....	2,965,412
1883	1,305,364	1,047,863	....	....	....	....	2,353,227
1884	1,559,912	895,634	1,022	62,122	....	....	2,518,690
1885	1,430,862	690,435	119,590	227,075	....	....	2,467,962
1886	1,627,383	880,006	756,237	307,948	....	....	3,571,574
1887	1,851,717	1,199,343	1,285,265	394,910	....	....	4,731,235
1888	1,918,672	1,191,097	1,433,689	511,953	....	....	5,055,411
1889	2,631,026	1,876,157	2,147,923	864,508	....	....	7,519,614
1890	2,863,848	2,274,192	2,914,081	891,910	....	....	8,944,031
1891	2,778,482	1,856,124	2,041,754	945,105	....	....	7,621,465
1892	2,848,552	2,402,195	3,058,176	1,226,220	29,245	....	9,564,388
1893	2,064,827	1,563,049	1,466,815	815,735	684,194	....	6,594,620
1894	1,935,379	1,255,255	1,523,451	1,055,229	1,913,234	....	7,682,548
1895	1,982,080	1,794,970	2,625,475	1,027,103	2,839,350	....	10,268,978
1896	2,418,846	1,763,235	2,100,398	1,200,907	3,082,973	....	10,566,359
1897	2,673,785	1,767,220	2,163,088	1,381,278	4,220,151	....	12,205,522
1898	2,987,930	2,275,664	2,552,205	1,125,538	4,837,971	....	13,779,308
1899	3,634,596	3,281,422	2,725,648	1,643,984	6,517,305	....	17,802,955
1900	3,945,068	3,680,738	3,104,033	1,675,949	8,158,450	....	20,564,238
1901	3,597,089	3,697,408	3,041,869	1,805,996	9,303,541	....	21,445,903
1902	3,734,712	4,421,250	3,683,792	2,057,532	13,080,118	....	26,977,404
1903	3,686,214	4,093,320	3,422,341	1,918,584	13,452,812	....	26,573,271
1904	2,465,448	2,871,130	2,132,898	1,056,430	11,672,405	....	20,198,311
1905	3,772,645	4,472,630	3,344,551	1,578,626	20,156,566	....	33,325,018
1906	4,070,914	4,962,357	3,484,023	1,794,186	23,564,891	....	37,876,371
1907	4,167,810	4,779,592	3,609,519	1,724,217	27,245,441	....	41,526,579
1908	3,309,917	2,904,011	3,241,931	927,206	17,725,014	....	28,108,079
1909	4,291,967	4,789,362	3,807,157	1,097,444	27,877,705	....	41,863,635
1910	4,631,427	4,983,729	4,746,818	1,390,360	30,576,409	....	46,328,743
1911	3,743,145	4,062,778	3,099,197	1,336,938	23,126,943	181,224	35,550,225
1912	3,545,012	4,465,466	3,926,632	1,457,273	32,604,756	369,739	46,368,878
1913	3,977,808	4,997,246	4,743,515	1,536,115	36,378,671	744,007	52,377,362
1914	3,320,763	3,671,499	4,601,240	1,362,416	19,808,434	776,051	33,540,403
1915	3,817,892	4,665,465	4,996,237	1,541,645	30,802,409	1,120,606	46,944,254
1916	4,792,987	6,649,578	7,707,101	1,704,440	41,325,341	1,555,641	63,735,088
1917	4,638,374	6,366,483	7,881,232	1,481,301	41,127,323	1,986,608	63,481,321
1918	3,946,554	6,041,637	7,837,634	1,192,677	39,055,977	1,705,315	59,779,794
	129,643,998	117,311,039	111,326,537	42,320,860	491,167,629	8,439,191	900,209,254

SHIPMENTS AND RECEIPTS.

According to the Iron Trade Review, 62,836,082 gross tons of iron ore were shipped in 1918 from the Lake Superior district, including the Iron Ridge and Baraboo areas in Wisconsin, compared with 64,437,003 tons in 1917. Of the total in 1918, there were 61,156,732 gross tons shipped by boat and 1,679,350 tons by rail, compared with 62,498,901 tons shipped by boat and 1,938,102 tons by rail in 1917. The shipments of iron ore from the Lake Superior iron-ore ranges and the Baraboo and Iron Ridge areas as reported to the Geological Survey in 1918 amounted to 62,018,296 gross tons, exclusive of manganiferous iron ore containing 5 per cent or more of manganese, compared with 63,854,752 tons in 1917.

Iron ore shipped from the Lake Superior district, 1914–1918, by ports, in gross tons.[a]

Shipping port.	1914	1915	1916	1917	1918
Escanaba, Mich.	3,664,451	5,649,289	7,457,444	7,156,854	6,774,969
Marquette, Mich.	1,755,726	3,099,589	3,858,092	3,207,145	3,457,054
Ashland, Wis.	3,363,419	5,146,772	8,057,814	7,597,841	7,565,608
Two Harbors, Minn.	5,610,262	8,642,942	10,735,853	9,990,901	8,723,472
Superior, Wis.	11,309,748	8,342,793	12,787,046	13,978,741	14,068,341
Duluth, Minn.	6,318,291	15,437,419	21,837,949	20,567,419	20,567,288
Total by lake.	32,021,897	46,318,804	64,734,198	62,498,901	61,156,732
Total by rail.	707,829	953,947	1,924,268	1,938,102	1,679,350
	32,729,726	47,272,751	66,658,466	64,437,003	62,836,082

[a] Iron Trade Review.

Iron ore shipped from the Lake Superior district, 1914–1918, by months, in gross tons.[a]

Month.	1914	1915	1916	1917	1918
April	269,686	503,832	1,658,411	211,532	235,870
May	3,832,063	5,012,359	8,449,580	6,283,612	8,792,231
June	5,502,367	6,005,091	9,507,576	9,639,991	9,921,860
July	5,784,514	7,204,020	9,750,157	10,241,633	10,659,203
August	5,869,477	8,081,117	9,850,140	10,146,786	9,725,331
September	5,431,307	7,863,146	9,600,786	9,536,152	8,995,014
October	4,242,392	7,146,873	9,116,196	8,193,892	8,541,593
November	1,068,681	4,445,129	5,715,452	7,333,828	4,279,025
December	1,411	57,236	1,085,900	911,475	6,836
Total by lake [b]	32,021,897	46,318,804	64,734,198	62,498.901	61,156,732
Total by rail	707,829	953,947	1,924,268	1,938,102	1,679,350
	32,729,726	47,272,751	66,658,466	64,437,003	62,836,082

[a] Iron Trade Review.
[b] Totals by seasons will be found to vary slightly from the sums of the monthly movements because of corrections.

Iron ore received at Lake Erie ports, 1914–1918, in gross tons.[a]

Port.	1914	1915	1916	1917	1918
Toledo	773,711	1,158,374	2,035,160	2,445,602	2,608,497
Huron	617,363	695,865	1,324,112	1,631,395	1,620,712
Lorain	1,677,988	3,517,258	4,613,929	3,831,244	3,494,370
Cleveland	5,519,698	7,504,697	10,669,745	9,077,161	9,681,882
Fairport	1,558,134	2,001,103	2,580,647	2,311,179	1,853,465
Ashtabula	5,318,788	7,813,101	11,474,268	10,251,304	11,001,574
Conneaut	6,263,480	8,573,509	9,588,341	8,729,754	6,650,898
Erie	260,991	707,875	1,525,031	2,079,227	1,809,619
Buffalo	2,913,273	5,339,724	7,432,220	7,843,215	8,845,775
Detroit	332,564	459,877	425,579	418,151	444,936
Port Colborne, Ontario, Canada	166,665	196,077	138,240	194,627	171,287
	25,402,655	37,967,460	51,807,272	48,812,859	48,183,015

[a] Iron Trade Review.

The difference between the shipments of Lake Superior ore and the receipts of Lake Erie ports is accounted for in large part by the quantity of ore delivered at Lake Michigan ports, South Chicago, Ill., Gary and Indiana Harbor, Ind., and Milwaukee, Wis., the receipts at those ports and at smaller places being shown in the table following. It is understood that there is also a loss, probably less than 1 per cent, in handling ore between mines and lower Lake ports.

Iron ore received at Lake Michigan ports, 1914–1918, in gross tons.[a]

Port.	1914	1915	1916	1917	1918
Elk Rapids, Mich	28,437	....	....	....	....
East Jordan, Mich	38,158	37,658	38,573	35,792	33,940
Milwaukee, Wis	93,121	187,286	239,219	224,570	166,626
Gary, Ind	1,631,564	2,421,924	2,718,185	3,883,082	3,848,295
Indiana Harbor, Ind	661,054	689,226	793,215	900,692	1,413,392
South Chicago, Ill	3,606,587	4,195,976	7,740,877	7,030,174	6,113,492
Boyne City, Mich	50,098	40,401	43,788	44,437	34,137
	6,109,019	7,572,471	11,573,857	12,118,747	11,609,882

[a] Iron Trade Review.

The following table shows the total quantity of iron ore shipped from the Lake Superior district since 1854, the date of the opening of the Marquette range, the oldest of the Lake Superior ranges. This table gives the shipments as published by the Iron Trade Review and is inserted for comparison with the table giving the total production of the Lake Superior district, without regard to shipments. Later tables show the uniformity with which stocks of iron ore were maintained at the close of navigation at the lower Lake ports during war years and the balances remaining at these ports at the opening of navigation the following spring seasons.

Iron ore shipped from the Lake Superior district, 1854–1918, in gross tons.[a]

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1854	3,000	1876	992,764	1898	14,024,673
1855	1,449	1877	1,015,087	1899	18,251,804
1856	36,343	1978	1,111,110	1900	19,059,393
1857	25,646	1879	1,375,691	1901	20,589,237
1858	15,876	1880	1,908,745	1902	27,571,121
1859	68,832	1881	2,306,505	1903	24,289,878
1860	114,401	1882	2,965,412	1904	21,822,839
1861	49,909	1883	2,353,288	1905	34,384,116
1862	121,169	1884	2,518,692	1906	38,565,762
1863	203,055	1885	2,466,372	1907	42,266,668
1864	243,127	1886	3,568,022	1908	26,014,987
1865	236,208	1887	4,730,577	1909	42,586,869
1866	278,796	1888	5,063,693	1910	43,442,397
1867	473,567	1889	7,292,754	1911	32,793,130
1868	491,449	1890	9,012,379	1912	48,221,546
1869	617,444	1891	7,062,233	1913	49,947,116
1870	830,940	1892	9,069,556	1914	32,729,726
1871	779,607	1893	6,060,492	1915	47,272,751
1872	900,901	1894	7,748,932	1916	66,658,466
1973	1,162,458	1895	10,429,037	1917	64,437,003
1874	919,557	1896	9,934,828	1918	62,836,082
1875	891,257	1897	12,469,638		
					897,689,362

[a] Iron Trade Review.

STOCKS OF IRON ORE AT LAKE ERIE PORTS.

Stocks of iron ore at Lake Erie ports, Dec. 1, 1914–1918, in gross tons.[a]

Port.	At close of navigation, Dec. 1—				
	1914	1915	1916	1917	1918
Toledo, Ohio	580,600	311,799	394,869	399,479	399,839
Sandusky, Ohio	2,471	1,871	....	....	....
Huron, Ohio	483,760	558,692	590,743	556,765	607,233
Lorain, Ohio	548,097	824,988	1,076,105	978,108	828,384
Cleveland, Ohio	1,757,543	1,795,962	1,936,906	1,914,071	2,117,176
Fairport, Ohio	406,124	413,994	474,930	586,580	510,855
Ashtabula, Ohio	2,749,315	2,870,204	3,266,752	3,435,624	3,292,738
Conneaut, Ohio	1,160,639	1,216,686	1,363,550	1,544,706	1,703,701
Erie, Pa	484,467	589,355	625,193	519,698	439,094
Buffalo, N. Y	234,880	326,800	438,712	441,318	525,947
	8,407,905	8,910,351	10,167,760	10,326,349	10,424,967

[a] Iron Trade Review.

Stocks of iron ore at Lake Erie ports May 1, 1915–1919, in gross tons.[a]

Port.	At opening of navigation, May—				
	1915	1916	1917	1918	1919
Toledo, Ohio	255,343	164,637	257,030	230,797	241,965
Sandusky, Ohio	2,471	....	....	....	....
Huron, Ohio	462,917	286,054	333,124	387,042	429,200
Lorain, Ohio	377,550	173,771	503,618	475,137	190,003
Cleveland, Ohio	1,592,783	772,721	970,973	933,687	1,259,120
Fairport, Ohio	283,591	198,636	237,645	329,528	326,621
Ashtabula, Ohio	1,963,233	1,176,142	1,660,818	1,744,448	1,740,072
Conneaut, Ohio	564,077	41,080	183,255	844,417	731,503
Erie, Pa	412,186	342,866	406,078	363,008	369,978
Buffalo, N. Y	178,152	187,498	219,691	313,925	392,623
	6,092,303	3,343,405	4,772,232	5,622,019	5,681,065

[a] Marine Review.

PRICES OF LAKE SUPERIOR IRON ORE.

Beginning with the season of 1907 the base for the old range and Mesabi Bessemer ore has been a metallic iron content of 55 per cent natural, and that of the old range and Mesabi non-Bessemer ore has been a metallic iron content of 51.5 per cent natural. For the years preceding 1907 the guaranty of Bessemer ores was 55.70 per cent iron natural, and for the non-Bessemer ores it was 52.80 per cent, except Mesabi non-Bessemer for 1905 and 1906, when the natural iron content was 53 per cent.

At Lake Erie ports for the season of 1917 and the first half of 1918 Mesabi Bessemer was listed at $5.70 a gross ton and Mesabi non-Bessemer at $5.05 a ton, compared with $4.20 and $3.55 a ton, respectively, for 1916; old range Bessemer was listed at $5.95 and old range non-Bessemer at $5.20 a ton for 1917 and the first half of 1918, compared with $4.45 and $3.70 a ton, respectively, for 1916. These prices represent advances of $1.50 a ton on all grades of ore, or from 34 per cent to 42 per cent. These advances, though considerable, were not proportionate to the advances in the prices of pig iron during the corresponding period (which averaged at the furnaces nearly 61 per cent), and iron ore producers succeeded in obtaining Government approval of an increase of 45 cents a ton on all grades of ore on July 1, 1918, and of 25 cents effective October 1, 1918. The prices established to take effect in April, 1919, involved a reduction of 20 cents a ton on all grades of Lake Superior iron ore, thus pricing old range Bessemer at $6.45, old range non-Bessemer at $5.70, Mesabi Bessemer at $6.20, and Mesabi non-Bessemer at $5.55 a ton, respectively. This reduction corresponded to the reduction of 20 cents a ton in vessel rates to lower Lake ports.

The values of units of iron in natural state for the four standard grades of Lake Superior ore for the last 17 years are shown in the Iron Trade Review.[a] Those established October 1, 1918, are: Old range Bessemer, 12.09 cents; Mesabi Bessemer, 11.64 cents; old range non-Bessemer, 11.46 cents; Mesabi non-Bessemer, 11.16 cents.

Selling prices of iron ore per gross ton at lower Lake ports at date of buying movement, 1890–1919.[b]

Season.	Date of buying movement.	Season iron-ore prices.			
		Old range Bessemer.	Mesabi Bessemer.	Old range non-Bessemer.	Mesabi non-Bessemer.
1890	Dec. 15, 1889	$5.50	No sale.	$5.25	No sale.
1891	June 1, 1891	4.50	No sale.	4.25	No sale.
1892	Jan. 31, 1892	4.50	No sale.	3.65	No sale.
1893	Mar. 15, 1893	3.85	$3.00	3.20	No sale.
1894	Mar. 1, 1894	2.75	2.35	2.50	No sale.
1895	Apr. 1, 1895	2.90	2.15	2.25	$1.90
1896	May 1, 1896	4.00	3.50	2.70	2.25
1897	May 20, 1897	2.60	2.25	2.15	1.90
1898	Mar. 20, 1898	2.75	2.25	1.85	1.75
1899	Feb. 1, 1899	3.00	2.40	2.15	2.00
1900	Dec. 15, 1899	5.50	4.50	4.25	4.00
1901	Apr. 15, 1901	4.25	3.25	3.00	2.75
1902	Feb. 1, 1902	4.25	3.25	3.25	2.75
1903	Mar. 20, 1903	4.50	4.00	3.60	3.20
1904	Apr. 15, 1904	3.25	3.00	2.75	2.50
1905	Feb. 1, 1905	3.75	3.50	3.20	3.00
1906	Dec. 5, 1905	4.25	4.00	3.70	3.50
1907	Nov. 5, 1906	5.00	4.75	4.20	4.00
1908	June 15, 1908	4.50	4.25	3.70	3.50
1909	May 10, 1909	4.50	4.25	3.70	3.50
1910	Dec. 24, 1909	5.00	4.75	4.20	4.00
1911	Apr. 21, 1911	4.50	4.25	3.70	3.50
1912	Mar. 20, 1912	3.75	3.50	3.00	2.85
1913	Nov. 19, 1912	4.40	4.15	3.60	3.40
1914	May 1, 1914	3.75	3.50	3.00	2.85
1915	Apr. 19, 1915	3.75	3.45	3.00	2.80
1916	Dec. 7, 1915	4.45	4.20	3.70	3.55
1917	Nov. 22, 1916	5.95	5.70	5.20	5.05
1918	Apr. 1, 1918	5.95	5.70	5.20	5.05
	July 1, 1918	6.40	6.15	5.65	5.50
	Oct. 1, 1918	6.65	6.40	5.90	5.75
1919	Apr. 28, 1919	6.45	6.20	5.70	5.55

[a] Iron Trade Review, May 8, 1919, p. 1240.

[b] Iron Trade Review.

MINING DEVELOPMENTS.

The outstanding features of activities in the Lake Superior iron mining districts are described in articles published early in 1919.[1] Among these features were the successful mining of the requisite quantity of iron ore in the face of a meager supply of labor, the greater part of which was less efficient than ever before; highest wages ever paid; further experimentation with labor-saving machinery; development of new ore bodies on the Gogebic range; development of new mines and approaching exhaustion of old ones on the Mesabi; war development of manganiferous ore deposits on the Cuyuna range; increase in building of ore washers; continuation of experimentation on concentration of lean magnetite of the eastern Mesabi range, and shipment of cargo of low-phosphorus concentrates to a furnace in eastern Pennsylvania; and finally the creditable ore-shipping record, accomplished with fewer ships than in any former war year, due to the effective mobilization and coordination of mining facilities, upper Lake ore-carrying railroads and docks, Lake fleets, and lower Lake receiving facilities and railroads.

IRON-ORE RESERVES.

In view of the heavy draft on ore reserves since the beginning of the European war a comparison of tonnage estimates at different periods is of interest. Data are available for the reserves in Minnesota and in Michigan, but not for Wisconsin. The ore reserves of Wisconsin are, however, much smaller than those of the other two States. The estimates of ore reserves in Minnesota were furnished by Rukard Hurd, Director of Mines, of the Minnesota Tax Commission, and those for Michigan by R. C. Allen, State geologist. The figures given in the following tables include developed and prospective ore in the ground and ore in stock piles.

The data for Minnesota and Michigan are not based on the same dates and are therefore not strictly comparable, but they show the trend of the balance between production and ore believed to be in reserve. In Minnesota the blocking out of new ore reserves during the year ending May 1, 1916, apparently more than kept pace with the depletion of the supplies, but during 1917 there was an apparent falling off of nearly 12,000,000 tons, and at the end of 1918 there was an apparent decrease of more than 26,000,000 tons. During 1918 drilling for ore was not active, or there probably would have been more ore discovered. In Michigan during the year 1916 exploration did not quite keep up with production, but at the end of 1917 there appears to have been an increase in the reserves of nearly 3,700,000 gross tons, or more than 20 per cent of the quantity mined in that State in 1917. In 1918 the ore reserves were apparently increased by about the same quantity as in 1917, so that on January 1, 1919, there were, including stocks on hand, 203,571,709 tons of ore available in Michigan, or more than at any other time since January 1, 1915, when there were 206,120,538 tons.[2]

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[1] Woodbridge, D. E., Notable features of Lake iron-ore trade: Iron Age, Jan. 2, 1919, pp. 50-52; Iron ore district wins war honors: Iron Trade Review, Jan. 16, 1919, pp. 201-206.

[2] Allen, R. C., Mineral resources of Michigan: Michigan Geol. and Biol. Survey Pub. 27, p. 90, 1918.

Iron-ore reserves in Minnesota May 1, 1915, 1916, 1917, and 1918, in gross tons.

Range.	1915.	1916.	1917.	1918.
Mesabi	1,389,003,652	1,384,635,891	1,381,754,428	1,362,277,471
Vermilion	11,011,974	13,058,280	11,961,684	12,251,025
Cuyuna	72,403,065	77,926,062	70,159,848	63,208,588
	1,472,418,691	1,475,620,233	1,463,875,960	1,437,737,084

Iron ore reserves in Michigan Jan. 1, 1916, 1917, 1918, and 1919, in gross tons.

Range.	1916.	1917.	1918.	1919.
Gogebic	45,932,974	47,152,084	55,813,661	63,497,143
Marquette	82,562,079	79,624,681	78,175,301	64,254,626
Menominee (including Iron River and Crystal Falls districts)	70,625,437	69,696,046	66,154,547	75,819,940
	199,020,490	196,472,811	200,143,509	203,571,709

FOREIGN TRADE IN IRON ORE.

IMPORTS.

The quantity of iron ore imported into the United States in 1918 was 787,468 gross tons, valued at $3,464,304, or $4.40 a ton. This represented a decrease in quantity of 184,195 tons, or 19 per cent, and in value of $191,088, or 5 per cent, as compared with the imports during 1917, which were 971,663 gross tons, valued at $3,655,392, or $3.76 a ton. As to the source of the imports in 1918, Cuba produced 80 per cent of the ore, Canada nearly 15 per cent, Spain nearly 5 per cent, and small quantities came from France and the United Kingdom. The accompanying diagram (fig. 6) indicates the source and destination of the iron ore imported into the United States.

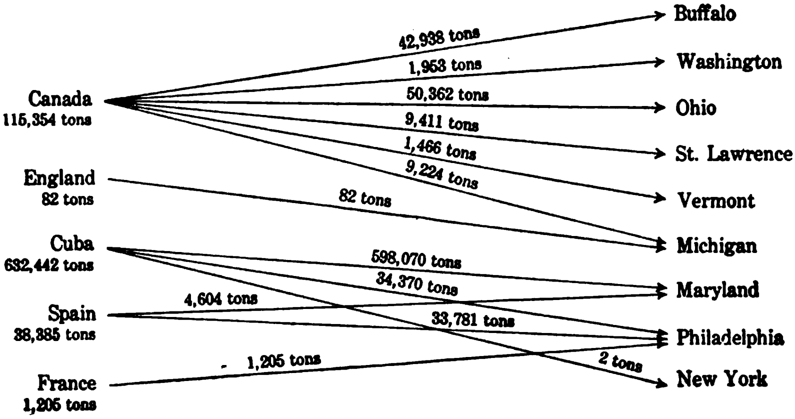
Canada
115,354 tons
England
82 tons
Cuba
632,442 tons
Spain
38,385 tons
France
1,205 tons
42,938 tons
1,953 tons
50,362 tons
9,411 tons
1,466 tons
9,224 tons
82 tons
598,070 tons
34,370 tons
4,604 tons
33,781 tons
1,205 tons
2 tons
Buffalo
Washington
Ohio
St. Lawrence
Vermont
Michigan
Maryland
Philadelphia
New York

FIGURE 6.—Source and destination of iron ore imported into the United States in 1918.

The statistics of imports of iron ore are compiled from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Iron ore imported into the United States, 1914–1918.

Country.	1914		1915		1916	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Cuba	815,017	$2,288,102	831,618	$2,450,163	715,571	$2,195,409
Spain	66,982	233,287	42,092	165,827	161,422	582,691
French Africa	46,175	114,781	21,825	47,272	38,004	95,342
Greece			738	2,895		
Newfoundland and Labrador	38,515	57,681				
United Kingdom	2,663	52,814			140	2,019
Germany	2,256	9,222				
Canada	52,514	153,415	84,124	245,092	136,835	509,572
Sweden	280,887	1,481,747	204,632	1,061,624	212,063	1,108,216
Chile	35,180	41,760	153,600	181,271	61,701	73,265
Other countries	[a] 10,399	[a] 51,023	[b] 2,652	[b] 27,501		
	1,350,588	4,488,832	1,341,281	4,181,645	1,325,736	4,566,514

Country.	1917		1918	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Cuba	546,069	$1,728,437	632,442	$2,376,399
Spain	152,713	582,644	38,385	458,234
French Africa	8,860	22,212		
United Kingdom	4,717	133,004	82	524
Canada	195,588	850,153	115,354	611,072
Sweden	63,715	338,936		
Other countries	[c] 1	6	[d] 1,205	18,075
	971,663	3,655,392	787,468	3,464,304

[a] Of this, 2,400 tons, valued at $3,600, was from Venezuela, and 6,050 tons, valued at $40,039, was from French Oceania.

[b] Of this, 2,638 tons, valued at $27,280, was from Egypt.

[c] Norway.

[d] France.

In the following table are shown the annual imports of iron ore into the United States as far as recorded. Iron ore was imported from Europe in large quantities for the first time in 1879, most of the imports prior to that date coming from Canada.

Iron ore imported into the United States, 1872–1918, in gross tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1872	23,733	1888	587,470	1905	845,651
1873	45,981	1889	853,573	1906	1,060,390
1874	57,987	1890	1,246,830	1907	1,229,168
1875	56,655	1891	912,864	1908	776,898
1876	17,284	1892	806,585	1909	1,694,957
1877	30,669	1893	526,951	1910	2,591,031
1878	28,212	1894	167,307	1911	1,811,732
1879[a]	150,197	1895	524,153	1912	2,104,576
1879[b]	284,141	1896	682,806	1913	2,594,770
1880	493,408	1897	489,970	1914	1,350,588
1881	782,887	1898	187,208	1915	1,341,281
1882	589,655	1899	674,082	1916	1,325,736
1883	490,875	1900	897,831	1917	971,663
1884	487,820	1901	966,950	1918	787,468
1885	390,786	1902	1,165,470		
1886	1,039,433	1903	980,440		38,808,036
1887	1,194,301	1904	487,613		

[a] Fiscal years end.

[b] Calendar years begin.

EXPORTS.

The quantity of iron ore exported from the United States in 1918 amounted to 1,256,383 gross tons, valued at $5,535,090, or $4.41 a ton, as compared with 1,132,313 gross tons, valued at $4,464,111, or $3.94 a ton, in 1917. This represents an increase in quantity of 124,070 tons, or 11 per cent, and in value of $1,070,979, or 24 per cent. All the ore exported in 1918 went to Canada.

The data regarding exports are compiled from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Iron ore exported from the United States, 1917–18.

Country.	1917		1918	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
England	45	$1,359	....	....
Canada	1,129,390	4,451,240	1,256,383	$5,535,090
Mexico	2,878	11,512	....	....
	1,132,313	4,464,111	1,256,383	5,535,090

Iron ore exported from the United States, 1899–1918, in gross tons.

Year.	Quantity.	Year.	Quantity.
1899	40,665	1910	748,875
1900	51,460	1911	768,386
1901	64,703	1912	1,195,742
1902	88,445	1913	1,042,151
1903	80,611	1914	551,618
1904	213,865	1915	707,641
1905	208,017	1916	1,183,962
1906	265,240	1917	1,132,313
1907	278,608	1918	1,256,383
1908	309,099		
1909	455,934		10,643,708

IRON-ORE INDUSTRY OF CUBA.

The iron ore shipped from Cuba to the United States in 1918 amounted to 643,532 gross tons, valued at $2,096,761, compared with 553,485 gross tons, valued at $2,793,113, in 1917, an increase in quantity of 90,047 tons, or 16 per cent, and a decrease in value of $696,352, or 25 per cent. The average selling price of the ore was apparently $3.26 a ton in 1918, compared with $5.05 in 1917. The shipments in 1918 consisted of 64 per cent of hematite, including a little magnetite, from the Daiquiri, Juragua, and Cuero mines on the southern coast, and of 36 per cent of brown ore from the Mayari mines, near the northern coast. In 1918 the iron content of the hematite, dried at 212° F., ranged from 53.95 per cent to 57.8 per cent and the brown ore carried 48.08 per cent (natural) and 56.77 per cent (nodulized), and in 1917, hematite (natural) ranged from 55.67 per cent to 58.61 per cent, with one report of dried ore that carried 58.81 per cent, and the brown ore carried 35.05 per cent (natural) and 54.23 per cent (nodulized). This seems to indicate that whereas less ore was mined at Mayari in 1918 a grade of ore higher than usual was selected for shipment. The Cuero mines, which have shipped nearly 1,000,000 tons of low-phosphorus ore since 1909, are reported as now practically exhausted. The total stock of ore reported as on hand at the end of 1918 was 1,263,595 gross tons, compared with 1,166,934 tons at the close of 1917. This included both natural and nodulized ore.

The following table shows the shipments of iron ore from Cuba since the opening of the mines in 1884. The curtailment of iron-ore production in Cuba as a result of the war in Europe is shown by these statistics. The sudden depression in the iron industry in 1914 reduced the Cuban ore output about 48 per cent as compared with 1913. In 1915 the output was about the same as in 1914, but in 1916, 1917, and 1918 the output was further restricted by the shortage of ships, notwithstanding the great need for these excellent and easily accessible ores at iron and steel plants on the eastern seaboard of the United States. The statistics of the Cuban iron-ore shipments are collected by the United States Geological Survey.

Iron ore shipped from mines in the Province of Oriente, Cuba, 1884–1918, in gross tons.

Year.	Juragua Iron Co. (Ltd.) (hematite and magnetite).	Sigua Iron Co. (hematite).	Spanish-American Iron Co.		Cuban Steel Ore Co. (hematite).	Ponupo Manganese Co., El Cuero iron mines (hematite).	Total.
			Daiquiri mines (hematite and a little magnetite).	Mayari mines (brown ore).			
1884	25,295						25,295
1885	80,716						80,716
1886	112,074						112,074
1887	94,240						94,240
1888	206,061						206,061
1889	260,291						260,291
1890	363,842						363,842
1891	264,262						264,262
1892	335,236	6,418					341,654
1893	337,155	14,020					351,175
1894	156,826						156,826
1895	307,503		74,991				382,494
1896	298,885		114,110				412,995
1897	[a] 248,256		[b] 206,029				454,285
1898	83,696		80,225				163,921
1899	161,783		211,442				373,225
1900	154,871		293,195				448.066
1901	199,764		[c] 334,974		17,651		552,389
1902	221,039		455,105		23,590		699,734
1903	155,898		467,629				623,527
1904	31,162		356,111				387,273
1905	139,828		421,331				561,159
1906	133,379		507,195				640,574
1907	181,063		469,111				650,174
1908	366,580		254,256				620,836
1909	356,659		519,752			59,721	936,132
1910	318,814		670,976	307,700		165,008	1,462,498
1911	355,132		252,717	387,791		168,074	1,163,714
1912	360,094		463,533	446,176		127,994	1,397,797
1913	369,213		591,322	491,713		130,183	1,582,431
1914	267,641		284,507	228,949		40,013	821,110
1915	215,032		245,590	300,896		65,930	827,448
1916	212,013		181,602	258,451		60,650	712,716
1917	39,784		181,028	287,904		44,769	553,485
1918	17,128		353,103	232,540		40,761	643,532
	7,431,215	20,438	7,989,834	2,942,120	41,241	903,103	19,327,951

[a] Of this quantity, 5,932 tons was sent to Pictou, Nova Scotia.
[b] Of this quantity, 51,537 tons was sent to foreign ports.
[c] Of this quantity, 12,691 tons was sent to foreign ports.

PRODUCTION OF IRON ORE IN PRINCIPAL COUNTRIES.

Since the beginning of the war in Europe authentic statistics of output of iron ore from most of the principal producing foreign countries have not been available. The importance that attached to foreign statistics and their interpretation after the United States became involved in the war has made it especially desirable to present as many of these figures as possible. The following table has been prepared from many more sources of information than were formerly utilized; consequently the data are not so uniform and in all probability are not so reliable as those obtained in times of peace directly from the governments concerned. Though the statistics are far from complete, and many of the figures are subject to revision, it is believed that the table will serve a useful purpose.

Iron ore produced in some principal countries, 1913–1918, in metric tons.

Country.	1913	1914	1915	1916	1917	1918	Source of data.[a]
North America:							
Canada[b]	279,084	222,130	361,165	249,638	195,321	187,626	1913–1918, 1.
Cuba[b]	1,607,750	834,248	840,687	724,119	562,341	653,829	1913–1918, 2.
Newfoundland[b]	1,456,882	575,088	787,854	918,135	801,366	769,821	1913–1918, 1.
United States	62,972,124	42,102,797	56,414,914	76,370,355	76,493,473	70,772,810	1913–1918, 2.
South America:							
Chile	14,100	63,506	147,100	56,166	5,000	2,743	1913–1917, 3; 1918, 2.
Venezuela[c]	58,141	2,438	....	....	....	....	1913–14, 4.
Europe:							
Austria-Hungary	5,318,531	4,182,421	[d]1,238,268	(e)	(e)	(e)	1913–1915, 5.
Belgium	150,450	82,360	4,720	30,430	17,000	500	1913–1918, 6.
France	21,917,870	11,251,753	620,254	1,680,684	2,034,721	1,671,851	1913, 7; 1914–1918, 17.
Germany	28,607,903	20,505,000	17,710,000	(e)	(e)	(e)	1913, 8; 1914–15, 5.
Greece	313,578	299,286	157,430	84,985	63,364	(e)	1913–1917, 9.
Italy	603,116	706,246	679,970	942,244	993,825	(e)	1913–1917, 10.
Luxemburg	7,333,382	5,007,457	6,139,434	6,752,207	4,509,150	(e)	1913–1917, 5.
Norway	544,443	652,273	714,917	879,840	(e)	(e)	1913, 11; 1914–1916, 5.
Portugal	49,182	6,639	(e)	(e)	(e)	(e)	1913–14, 5.
Russia	9,513,945	(e)	(e)	(e)	(e)	(e)	1913, 12.
Spain	9,861,668	6,819,964	5,617,839	5,856,861	5,551,071	(e)	1913–1917, 13.
Sweden	7,475,571	6,586,630	6,883,308	6,986,298	6,217,172	(e)	1913–1917, 14.
United Kingdom	16,253,285	15,105,463	14,462,772	13,710,573	15,083,266	15,285,083	1913–1917, 15; 1918, 5.
Asia:							
China	[f]423,003	[f]496,071	545,819	278,555	304,356	(e)	1913–14, 16; 1915–1917, 5.
Chosen (Korea)	142,012	181,987	209,883	245,355	(e)	(e)	1913–1916, 4.
India	376,779	448,741	396,514	418,346	419,885	(e)	1913–1917, 5.
Japan	171,656	136,385	136,121	158,815	(e)	(e)	1913–1916, 4.
Africa:							
Algeria	1,348,899	1,115,021	818,705	938,684	1,065,502	782,047	1913, 7; 1914–1918, 5.
Morocco	(e)	(e)	189,190	(e)	(e)	(e)	1915, 5.
Tunis	594,199	248,522	285,899	367,499	606,000	(e)	1913–1917, 5.
Australia	(e)	180,785	376,821	396,350	490,236	(e)	1914–1917, 5.

[a] 1, Canada Dept. Mines, Mines Branch; 2, U. S. Geological Survey; 3, Anuario estadístico de la República de Chile; 4, Bur. Foreign and Domestic Commerce; 5, National Federation of Iron and Steel Manufacturers (London); 6, Statistique des industries extractives et metallurgiques; 7, Statistique de l'industrie minérale; 8, Vierteljahrshefte zur Statistik; 9, Tableaux statistiques du mouvement minier; 10, Rivista del Servizio minerario; 11, Norges Officielle Statistik; 12, Russian Gornago Department of Mining and Metallurgical Industries; 13, Estadística minera de España; 14, Bergshantering Sveriges Officiella Statistik; 15, Mines and Quarries (London); 16, Iron Trade Review; 17, Report on the iron situation in France, by Ernest L. Ives, American Consul, Paris.

[b] Shipments.

[c] Exports.

[d] Hungary only.

[e] Statistics not available.

[f] From Tayeh deposits only.

BENEFICIATED IRON ORE.

Statistics of beneficiated iron ore have been gathered by the Survey for the years beginning with 1914 and, although complete returns were not at first received from every producer who subjects his ore to any form of beneficiation, the responses to the special inquiries have been, on the whole, satisfactory and interesting and have shown continued improvement.

The following processes were reported as employed to improve the quality of the ore at various mines: Crushing and screening, drying, by direct heat and by steam, hand picking on tables and on belts, washing by means of hydraulic jets and logs, jigging, electromagnetic cobbing, other concentration and separation, calcining, nodulizing, and desulphurization by sintering. Some of the operations combined two or more of these processes. Iron ores were reported as beneficiated at 101 mines in 15 States in 1918 and at 94 mines in 16 States in 1917, and in addition at the brown-ore mines of the Spanish-American Iron Co. in the Mayari district, Cuba. In addition to these processes some iron ore is recovered in the form of blast-furnace ore dust, but no statistics have been gathered on this subject. Ore so recovered has been originally accounted for in the statistics of shipments from the mines.

In Alabama the ore treated was principally brown ore, and the usual processes to which it was subjected were log washing, screening, and picking belt. A total of 986,630 gross tons of beneficiated ore, valued at $3,323,329, was marketed from 25 mines in Alabama in 1918, compared with 1,159,624 tons, valued at $3,324,715, from 19 mines in 1917. Of this quantity 340,045 tons, valued at $1,013,198, was hematite run over a picking belt.

One mine in Connecticut, 11 in Georgia, 1 in Iowa, 1 in Maryland, 1 in Massachusetts, and 1 in Missouri reported the concentration of brown ore in 1918.

Hematite was beneficiated at 2 mines in Michigan and at 21 mines in Minnesota in 1918. Washing and drying were the principal processes employed, and 1 mine reported crushing and picking also in 1917.

Seven mines reported magnetic concentration of magnetite in New Jersey; at 2 of them dry tables were employed in addition and at 1 roasting was also employed; 2 mines reported hand cobbing. At 1 mine in North Carolina, which produces magnetite, the ore was subjected to a rough concentration consisting of electromagnetic cobbing, and 3 mines reported washing of brown ore in 1918.

In New York beneficiation of magnetite was reported by 10 mines. The magnetite was mainly concentrated magnetically, although at 1 mine only crushing and hand picking on a slow-moving belt were reported. The total shipments of beneficiated ore in New York amounted to 716,378 gross tons, valued at $4,840,642, in 1918, compared with 958,979 tons, valued at $5,446,881, in 1917.

In Pennsylvania 1 mine reported washing brown ore; at 1 mine the Gröndal concentrating process was employed; 1 magnetite mine reported desulphurization by sintering. The shipments of beneficiated ore from this State amounted to 273,874 gross tons, valued at $1,567,473, in 1918, compared with 215,380 tons, valued at $1,031,296 in 1917.

In Tennessee hematite from the mines of the Rockwood-Cardiff area was improved by breaking and hand picking, and brown ore from 9 mines in the west-central belt was beneficiated. At 5 of these brown-ore mines washing was reported as the only method; the others reported hand picking, crushing, washing, and jigging. In all probability, however, hand picking is employed to a greater or less extent at nearly all brown-ore mines at which the ore occurs with gravel. Calcining of brown ore is practiced at one cold-blast furnace. The total beneficiated iron ore shipped from mines in Tennessee in 1918 was 235,237 gross tons, valued at $692,999, compared with 334,254 tons, valued at $739,505, in 1917.

Three mines reported beneficiation of brown ore in Virginia in 1918, compared with 6 in 1917. The total shipments of treated ore in 1918 amounted to 77,134 gross tons, valued at $245,967, compared with 134,215 tons, valued at $350,203, in 1917. Washing, crushing, screening, and jigging were the methods employed in treating the brown ore.

The brown ores of the Mayari mines, Cuba, have been nodulized for many years at an extensive plant at Fenton, on Nipe Bay. The total quantity of this ore reported as shipped in 1918 amounted to 229,340 gross tons, compared with 285,724 tons in 1917.

The total beneficiated ore reported as shipped from mines in the United States in 1918 amounted to 7,881,570 gross tons, valued at $29,397,875, compared with 8,166,564 tons, valued at $27,733,036, in 1917. This represents a decrease in quantity of 284,994 tons, or 3.5 per cent, and an increase of $1,664,839, or 6 per cent, in value. From such figures as are available, showing the relation between crude ore treated and beneficiated ore recovered, it is apparent that in washing brown ore the ratios, by weight, of crude ore washed to resultant concentrates range from 8:1 to 1.166:1; in concentrating hematite, the ratios range from 2.128:1 to 1.025:1; and in magnetite they range from 3.534:1 to 1.052:1.

Beneficiated iron ore shipped from mines in the United States, 1917 and 1918.

State.	Variety.	1917		1918	
		Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Alabama	Hematite, brown ore	1,159,624	$3,324,715	986,630	$3,323,329
Georgia	Brown ore	88,156	223,171	107,244	434,227
Minnesota	Hematite	4,576,626	13,471,608	5,012,060	15,859,429
New Jersey	Magnetite	471,253	2,325,723	370,373	1,935,920
New York	Brown ore, magnetite	958,979	5,446,881	716,378	4,840,642
North Carolina	do	38,163	216,929	45,492	248,709
Pennsylvania	do	215,380	1,031,296	273,874	1,567,473
Tennessee	Hematite, brown ore, magnetite.	334,254	739,505	235,237	692,999
Virginia	Brown ore, magnetite	134,215	350,203	77,134	245,967
Other States[a]	Hematite, brown ore, magnetite.	189,914	603,005	57,148	249,180
		8,166,564	27,733,036	7,881,570	29,397,875

[a] 1917: Connecticut, Iowa, Maryland, Massachusetts, Michigan, Missouri, and New Mexico; 1918: Connecticut, Massachusetts, Michigan, and Missouri.

IRON AND STEEL.

The records of the production and sales of iron and steel in 1918, in comparison with former years are shown in the following pages, the data being derived in part from the producers who report directly to the United States Geological Survey, and from several other authoritative sources, such as the American Iron and Steel Institute, Metal Statistics, the Iron Age, the Iron Trade Review, and the Bureau of Foreign and Domestic Commerce of the Department of Commerce.

PIG IRON.

SHIPMENTS, VALUE, AND PRODUCTION, BY STATES.

According to reports to the United States Geological Survey by the manufacturers, the shipments of pig iron, exclusive of ferroalloys, in 1918, amounted to 38,230,440 gross tons, valued f. o. b. at the furnaces at $1,180,759,565, as compared with 38,612,546 tons, valued at $1,053,785,975, in 1917, a decrease in quantity of 382,106 tons, or 1 per cent, and an increase in gross value of $126,973,590, or 12 per cent. These values represent the approximate amounts received for the iron f. o. b. at the furnaces and eliminate freight costs, selling commissions, and other items which are included in some of the market prices of pig iron as published in the trade journals.

The pig iron shipped includes the metal produced from foreign as well as from domestic ore. The quantity and value of pig iron derived from ore imported from Canada, Cuba, Spain, and other countries, although it constitutes a very small percentage of the total production, is considerable, as it is calculated that the shipments derived from foreign ore in 1918 amounted to 452,300 gross tons, valued at $15,923,400, as compared with 505,216 tons, valued at $14,381,196, in 1917. In the manufacture in 1918 of 451,000 gross tons of pig iron, 779,369 gross tons of foreign iron ore, including 89,276 tons of cinder derived from foreign pyrite, were reported to have been used, thus indicating an average pig-iron yield of 57.86 per cent, as compared with the quantity of imported ore. Domestic ore, including 5,254,687 tons of cinder, scale, and scrap, and amounting to 75,160,234 gross tons, was reported in 1918 as used in the manufacture of 37,679,786 tons of pig iron, thus indicating a yield of 50.13 per cent in pig iron from the domestic materials. The total production in 1918 of pig iron, exclusive of ferroalloys, reported to the Geological Survey was 38,130,786 gross tons.

It is possible to show for the first time in the statistics of the output of pig iron the shipments and their value at the furnaces of pig iron by the principal grades. These figures, which do not include ferroalloys, are given for 1918 in the second following table.

Pig iron shipped from blast furnaces in the United States in 1917 and 1918.

State.	1917.		1918.		Change in 1918.		Percentage of change, 1918.	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity.	Value.
Alabama	2,971,626	$64,309,714	2,645,179	$80,893,687	− 326,447	+$16,583,973	− 11.0	+ 25.8
Illinois	3,458,126	91,094,541	3,409,876	105,415,030	− 48,250	+ 14,320,489	− 1.4	+ 15.7
Indiana	(a)	(a)	2,583,375	75,149,991	(b)	(b)	(b)	(b)
Kentucky	192,204	5,532,367	234,952	8,031,994	+ 42,748	+ 2,499,627	+ 22.2	+ 45.2
Michigan	611,446	18,300,501	502,884	17,823,684	− 108,562	− 476,817	− 17.8	− 2.6
Missouri	(a)	(a)	83,432	3,084,136	(b)	(b)	(b)	(b)
New Jersey	187,753	6,618,536	222,418	7,611,885	+ 34,665	+ 993,349	+ 18.5	+ 15.0
New York	2,276,367	52,318,661	2,482,450	70,167,542	+ 206,083	+ 17,848,881	+ 9.1	+ 34.1
Ohio	8,469,052	231,165,093	8,711,205	263,189,621	+ 242,153	+ 32,024,528	+ 2.9	+ 13.9
Pennsylvania	15,423,262	460,677,474	14,701,252	465,859,029	− 722,010	+ 5,181,555	− 4.7	+ 1.1
Tennessee	346,638	9,102,441	342,538	11,672,606	− 4,100	+ 2,570,165	− 1.2	+ 28.2
Virginia	562,299	15,703,295	453,863	15,430,473	− 108,436	− 272,822	− 19.3	− 1.7
Wisconsin	402,732	11,032,274	363,225	13,832,908	− 39,507	+ 2,800,634	− 9.8	+ 25.4
Other States [c]	3,711,041	87,931,078	1,493,791	42,596,979	+ [b]449,557	+[b] 32,900,028	+[b]12.1	+[b]37.4
	38,612,546	1,053,785,975	38,230,440	1,180,759,565	− 382,106	+ 126,973,590	− 1.0	+ 12.0

[a] Included with "Other States."

[b] Increases in Indiana and Missouri included in "Other States."

[c] 1917: Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, Washington, and West Virginia. 1918: Colorado, Connecticut, Georgia, Maryland, Massachusetts, Minnesota, Washington, and West Virginia.

Pig iron shipped from blast furnaces in the United States in 1918, by grades.

Grade.	Quantity (gross tons).	Value.	Average price a ton.
Charcoal	344,507	$13,392,324	$38.87
Foundry	5,295,262	176,959,909	33.42
Basic	18,621,883	544,770,305	29.25
Bessemer	11,751,540	360,901,939	30.71
Low phosphorus	598,927	31,459,638	52.53
Malleable	1,182,727	39,268,446	33.20
Forge	366,356	11,668,069	31.85
All other (not ferroalloys)	69,238	2,338,935	33.78
	38,230,440	1,180,759,565	30.89

The bureau of statistics of the American Iron and Steel Institute reports the production in 1918 of all kinds of pig iron, including such ferroalloys as spiegeleisen, ferromanganese, ferrosilicon, and ferrophosphorus, produced in blast furnaces as well as some that were electrically produced, as amounting to 39,054,644 gross tons, compared with 38,621,216 tons produced in 1917, an increase of 433,428 tons, or a little more than 1 per cent.

Pig iron, including some ferroalloys, manufactured in the United States in 1917 and 1918 in gross tons.[a]

State.	1917	1918	State.	1917	1918
Pennsylvania	15,539,728	15,198,271	Virginia	520,311	513,737
Ohio	8,518,603	8,764,132	Missouri	453,742	504,463
Illinois	3,456,915	3,440,307	Iowa		
Alabama	2,953,705	2,587,852	Colorado		
Indiana	2,657,503	3,073,599	Washington		
Michigan			Oregon		
New York	2,417,527	2,871,118	California		
New Jersey			Maryland	422,212	373,817
Wisconsin	738,541	750,366	Tennessee	369,951	369,822
Minnesota			Connecticut	10,527	12,485
West Virginia	561,951	594,675	Massachusetts		
Georgia			Maine		
Kentucky				38,621,216	39,054,644

[a] Bureau of statistics of the American Iron and Steel Institute.

AVERAGE PRICES.

The average price per gross ton of all kinds of pig iron, by States, from 1913 to 1918, given in the following table is based on reports of the manufacturers to the Survey. These figures represent the approximate prices f. o. b. at the blast furnaces and do not include the prices of ferroalloys.

The general average prices for 1916 to 1918 appear low for such active years in the iron industry. At the close of 1916 market prices of pig iron were between 45 and 68 per cent higher than at the beginning of the year, but this increase was confined almost entirely to the last two or three months of the year (see fig. 7), so that the average increase in price was only 28 per cent as compared with 1915. In 1917, however, the course of prices was very different, for at the beginning and end of the year prices were more nearly the same with the high levels at the middle of the year. The regulation of prices by the Government in the latter part of 1917, which continued until after the armistice was signed in November, 1918, prevented any spectacular rise in price during this period. The curve of market prices by months of basic iron at Valley furnaces (fig. 8) reflects the conditions. The general average price for all grades of pig iron at the furnaces, exclusive of ferroalloys, for the year 1918 was $30.89, as compared with $27.29 in 1917, an increase of $3.60 a ton, or 13 per cent. The States in which the average selling price of pig iron was more than $35 a ton in 1918 were Connecticut, Georgia, Massachusetts, Missouri, Michigan, and Wisconsin.

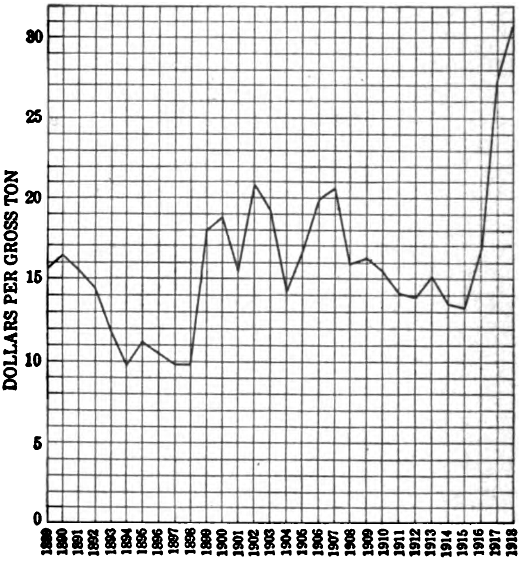

FIGURE 7.—Curve of average price per gross ton of pig iron in the United States, 1889—1918.

Average price per gross ton of pig iron in the United States, 1913-1918.

State.	1913	1914	1915	1916	1917	1918
Alabama	$12.08	$10.52	$10.24	$14.59	$21.64	$30.58
Illinois	15.83	13.59	13.93	17.57	26.34	30.91
Indiana	(a)	(a)	(a)	(a)	(a)	29.09
Kentucky	16.09	12.24	13.44	17.97	28.78	34.19
Michigan	14.69	13.78	13.63	17.51	29.93	35.44
Missouri	(a)	(a)	(a)	(a)	(a)	36.97
New Jersey	(a)	(a)	(a)	(a)	35.25	34.22
New York	15.35	14.26	14.02	17.70	22.98	28.27
Ohio	15.02	13.46	12.96	15.75	27.30	30.31
Pennsylvania	15.36	13.78	13.69	17.95	29.87	31.69
Tennessee	13.22	12.05	12.09	15.13	26.26	34.08
Virginia	13.96	12.53	12.83	16.06	27.93	34.00
Wisconsin	15.13	13.35	13.20	17.77	27.39	38.08
Other States[b]	15.50	13.55	12.96	16.03	24.25	28.52
Average for United States	15.08	13.42	13.21	16.96	27.29	30.89

[a] Included in "Other States."

[b] 1913: California, Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia; 1914: California, Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, New Jersey, and West Virginia; 1915: Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia; 1916: California, Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia; 1917: Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, Washington, and West Virginia; 1918: Colorado, Connecticut, Georgia, Maryland, Massachusetts, Minnesota, Washington, and West Virginia.

In the following summary of the annual average price per gross ton of pig iron in the United States for the years 1889 to 1918 the prices prior to 1907 include the cost of transportation of some pig iron from blast furnaces to markets. Prior to 1910 the values of blast furnace ferroalloys are included. Since 1910 the prices represent, as closely as can be ascertained, the average price paid for pig iron at the blast furnaces. The extreme range in prices is from $9.76 in 1894 to $30.89 in 1918. The lowest prices were in the years 1894 to 1898, and the highest were in the years 1902 to 1907 and 1917-1918. The curve of these prices is shown in figure 7.

Average price per gross ton of pig iron in the United States, 1889–1918.

1889	$15.78	1899	$18.00	1909	$16.25
1890	16.43	1900	18.85	1910	15.45
1891	15.50	1901	15.25	1911	14.07
1892	14.32	1902	20.92	1912	13.93
1893	11.90	1903	19.12	1913	15.08
1894	9.76	1904	14.13	1914	13.42
1895	11.14	1905	16.63	1915	13.21
1896	10.47	1906	19.98	1916	16.96
1897	9.85	1907	20.56	1917	27.29
1898	9.90	1908	15.96	1918	30.89

MARKET PRICES.

The average monthly prices of the principal grades of pig iron either at the blast furnaces or at the nearest market during the war period, according to published market quotations, are of interest in comparison with the general average prices per ton of pig iron in the United States reported to the Survey by blast-furnace operators. The accompanying diagram (fig. 8) graphically shows the price curve of basic pig iron at the blast furnaces in the Mahoning and Shenango valleys, Ohio and Pennsylvania, 1912 to 1918, inclusive. Beginning at $30 a ton in December, 1916, the price rose almost steadily from February to July, 1917, when it reached $52.50 a ton, according to the Iron Age ($53.52, according to Metal Statistics). These figures are among the top prices paid for pig iron of this grade since the Civil War.

The effect of Government regulation brought down pig iron prices precipitately so that from October, 1917, until March 31, 1918, basic iron was stationary at $33 a ton. During 1918 there was no normal market. The demand for iron for war purposes exceeded the supply but the requirements of manufacturers of war material were satisfied so far as was possible through allocations placed by Government authority. Pig-iron producers desired higher prices for the second quarter of 1918, but the War Industries Board ordered a reduction of $1 a ton, effective April 1, making basic iron $32 a ton at Valley furnaces. On October 1 all grades of pig-iron, except Bessemer, were advanced $1 a ton, by authority of the War Industries Board, the price of basic iron thus being brought up to $33 once more. Beginning October 1 a partial zoning of pig-iron prices was adopted in order to put Virginia and Tennessee blast furnaces on a more equitable basis as compared with those in the Pittsburgh and Birmingham districts, and to this end furnaces north of the Potomac and east of the Alleghenies were permitted to quote prices based on Pittsburgh and those south of Ohio and Potomac rivers were given Birmingham as a basing point.

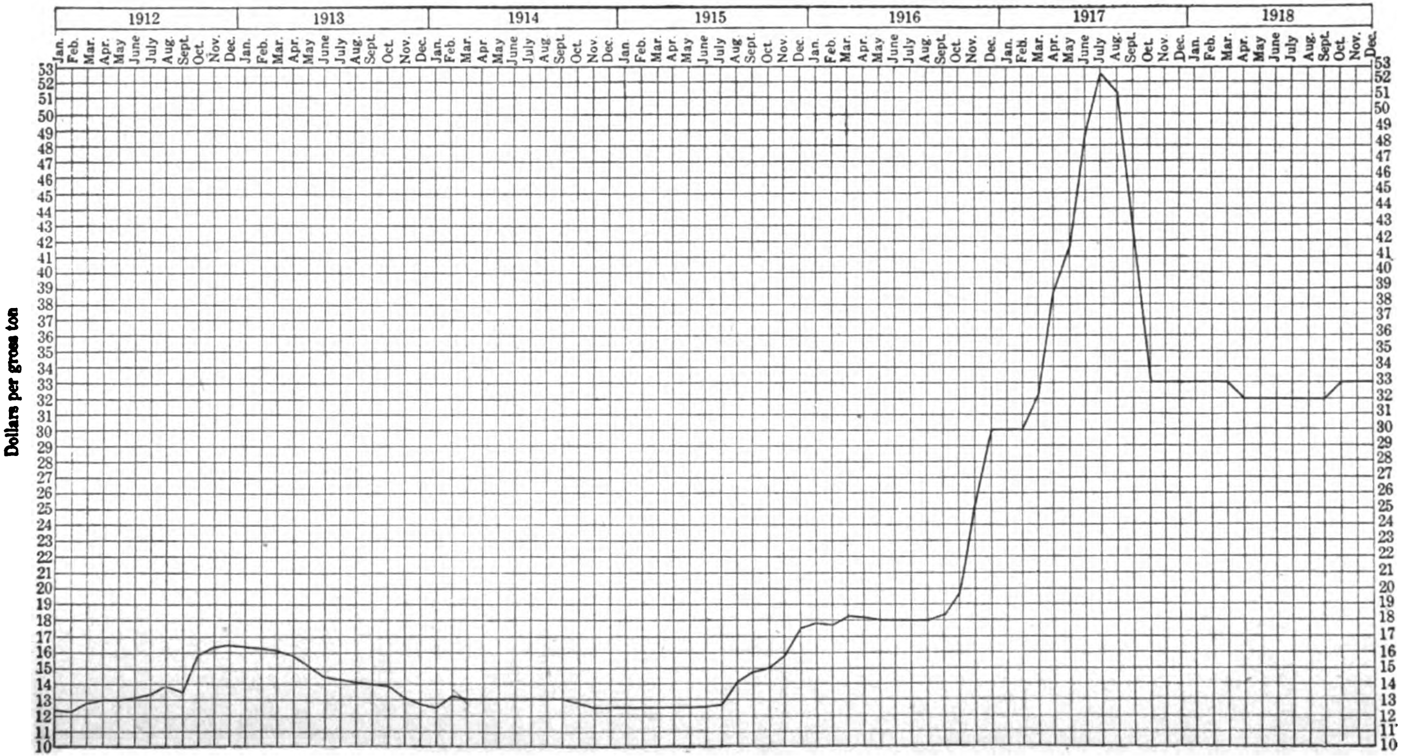

FIGURE 8.—Curve showing prices of basic pig iron at blast furnaces in Mahoning and Shenango valleys, Ohio and western Pennsylvania, 1912 to 1918, by months. Statistics from the Iron Age, Jan. 2, 1919, p. 18.

Average monthly prices per ton of principal grades of pig iron, 1917 and 1918.[a]

Month.	1917				1918			
	Foundry pig iron at Valley furnaces.	Foundry pig iron at Birmingham, Ala., furnaces.	Bessemer pig iron at Valley furnaces.	Basic pig iron at Valley furnaces.	Foundry pig iron at Valley furnaces.	Foundry pig iron at Birmingham, Ala., furnaces.	Bessemer pig iron at Valley furnaces.	Basic pig iron at Valley furnaces.
January	$30.00	$24.27	$35.00	$30.00	$33.00	$33.00	$36.30	$33.00
February	30.00	24.13	35.00	30.00	33.00	33.00	36.30	33.00
March	34.96	29.67	36.70	31.93	33.00	33.00	36.13	32.85
April	39.16	33.80	41.36	38.52	33.00	33.00	35.20	32.00
May	42.65	36.62	44.12	41.46	33.00	33.00	35.20	32.00
June	49.19	40.92	53.50	49.23	33.00	33.00	35.20	32.00
July	53.00	45.36	55.56	53.52	33.00	33.00	35.20	32.00
August	53.00	45.00	54.26	51.70	33.00	33.00	35.20	32.00
September	47.68	42.60	47.58	43.80	33.20	33.20	35.20	32.20
October	33.00	33.00	36.30	33.00	34.00	34.00	35.20	33.00
November	33.00	33.00	36.30	33.00	34.00	34.00	35.20	33.00
December	33.00	33.00	36.30	33.00	34.00	33.16	35.20	33.00
Average	39.89	35.11	42.67	39.10	33.27	33.20	35.46	32.50

[a] Metal Statistics, 1919.

BLAST FURNACES.

The number of furnaces in blast on June 30 and December 31 and the total number of stacks recorded for the years 1917 and 1918, not including any electric reduction furnaces, as published by the bureau of statistics of the American Iron and Steel Institute, are as follows:

Blast furnaces in the United States, 1917 and 1918.

State.	Furnaces in blast June 30, 1917.	Dec. 31, 1917.			Furnaces in blast June 30, 1918.	Dec. 31, 1918.		
		In.	Out.	Total.		In.	Out.	Total.
Pennsylvania	136	122	41	163	137	127	38	165
Ohio	72	64	15	79	71	74	5	79
Illinois	22	17	7	24	24	23	2	25
Alabama	34	34	13	47	31	30	14	44
New York	21	21	4	25	24	23	4	27
Virginia	12	15	4	19	13	13	6	19
Tennessee	12	10	6	16	12	9	7	16
Colorado	4	3	3	6	4	3	3	6
Missouri	2	2	0	2	2	3	0	3
Oregon	0	0	1	1	0	0	1	1
Washington	0	0	1	1	1	1	0	1
Maryland	4	2	3	5	4	3	2	5
New Jersey	4	5	0	5	4	3	2	5
Wisconsin	6	5	3	8	4	5	3	8
Minnesota	3	3	0	3	3	3	0	3
Indiana	12	13	1	14	15	16	0	16
Michigan	12	12	2	14	11	12	2	14
West Virginia	4	3	1	4	3	4	0	4
Kentucky	4	4	3	7	5	5	2	7
Georgia	0	1	3	4	0	0	4	4
Texas	0	0	2	2	0	0	2	2
Mississippi	0	0	1	1	0	0	1	1
Connecticut	2	2	1	3	2	2	0	2
Massachusetts	1	1	1	2	1	1	1	2
	367	339	116	455	371	360	99	459

MONTHLY PRODUCTION OF PIG IRON.

The accompanying diagram (fig. 9) illustrates the daily average production of coke and anthracite pig iron by months during the last six years. The decline from the middle of 1913 to the close of

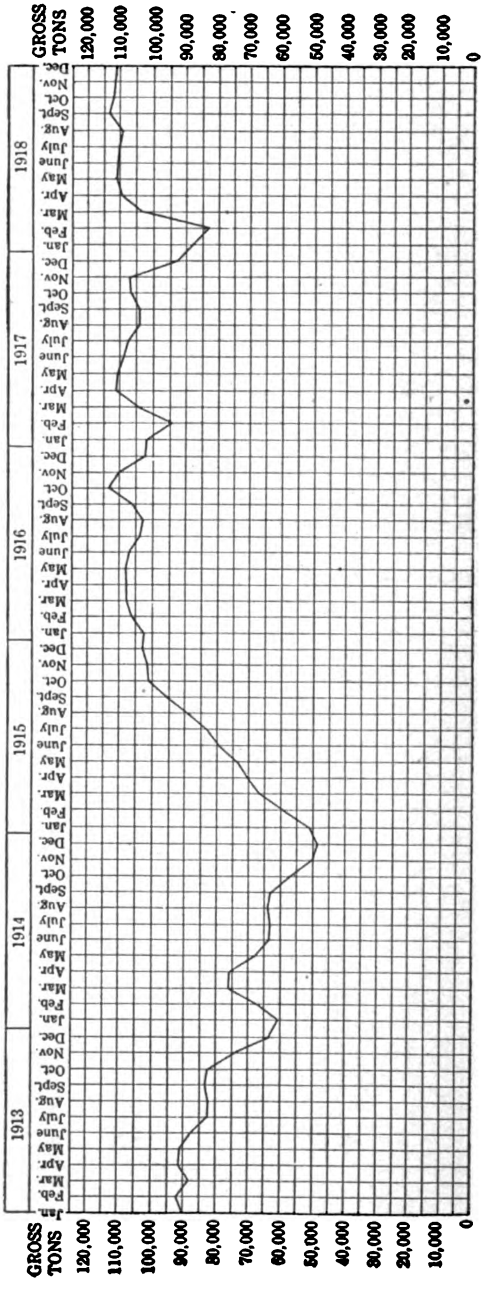

FIGURE 9.—Curve showing daily average production of coke and anthracite pig iron in the United States, by months, 1913–1918. Statistics from the Iron Age, Jan. 9, 1919, p. 138.

1914, the rapid rise in production from month to month throughout 1915, the high level maintained continuously above 100,000 tons a day throughout 1916, culminating in the record production in October of a daily average of 113,189 gross tons, the generally high level maintained in 1917 and 1918 broken only by decreases to below 100,000 tons in February and December, 1917, and January, 1918, are graphically indicated.

PRODUCTION OF PIG IRON, BY GRADES.

The statistics of production of the principal grades of pig iron for 1914 to 1918 have been published by the American Iron and Steel Institute as follows:

Pig iron manufactured in the United States, 1914–1918, by grades, in gross tons.

Grade.	1914	1915	1916	1917	1918
Bessemer and low phosphorus	7,859,127	10,523,306	14,422,457	13,714,732	13,024,966
Basic (mineral fuel)	[a] 9,670,687	[a] 13,093,214	17,684,087	17,671,662	18,646,174
Forge pig iron	361,651	316,214	348,344	345,707	393,932
Foundry and ferrosilicon	4,533,254	4,843,899	5,553,644	5,328,258	5,145,260
Malleable	671,771	829,921	921,486	1,015,579	1,117,914
Spiegeleisen	79,935	97,885	194,002	192,985	283,853
Ferromanganese	106,083	149,521	221,532	260,125	333,027
White, mottled, direct castings, etc	49,736	62,253	89,245	92,168	109,518
	23,332,244	29,916,213	39,434,797	38,621,216	39,054,644

[a] Includes a small quantity of basic iron made with charcoal.

PRODUCTION OF PIG IRON ACCORDING TO FUEL USED.

In the following table are given the statistics of the American Iron and Steel Institute showing the production of pig iron, including ferroalloys, according to the fuel used, from 1914 to 1918. Metal made with electricity, and coke and electricity, is included in coke pig iron. The charcoal figures for 1914 and 1915 also include small quantities of ferroalloys made with charcoal and electricity.

Pig iron manufactured in the United States, 1914–1918, by fuel used, in gross tons.

Fuel used.	1914	1915	1916	1917	1918
Bituminous, chiefly coke	22,976,856	29,535,308	38,844,598	37,863,643	38,422,175
Anthracite and coke	89,569	84,753	217,788	381,048	283,592
Anthracite alone	1,895	....	....	....	....
Charcoal	263,924	296,152	372,411	376,525	348,877
	23,332,244	29,916,213	39,434,797	38,621,216	39,054,644

TOTAL DOMESTIC PRODUCTION OF PIG IRON.

The next table shows the production in the United States of pig iron, including the commoner ferroalloys, as far as has been recorded. The statistics for 1912 to 1918 are those of the American Iron and Steel Institute; those for the years from 1854 to 1911 were collected by the American Iron and Steel Association; those for 1810, 1840, and 1850 are census figures; those for the other years are largely estimates by early statisticians.

Pig iron manufactured in the United States, 1810–1918, in gross tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1810	53,908	1867	1,305,023	1894	6,657,388
1820	20,000	1868	1,431,250	1895	9,446,308
1828	130,000	1869	1,711,287	1896	8,623,127
1829	142,000	1870	1,665,179	1897	9,652,680
1830	165,000	1871	1,706,793	1898	11,773,934
1831	191,000	1872	2,548,713	1899	13,620,703
1832	200,000	1873	2,560,963	1900	13,789,242
1840	286,903	1874	2,401,262	1901	15,878,354
1842	215,000	1875	2,023,733	1902	17,821,307
1846	765,000	1876	1,868,961	1903	18,009,252
1847	800,000	1877	2,066,594	1904	16,497,033
1848	800,000	1878	2,301,215	1905	22,992,380
1849	650,000	1879	2,741,853	1906	25,307,191
1850	563,755	1880	3,835,191	1907	25,781,361
1852	500,000	1881	4,144,254	1908	15,936,018
1854	657,337	1882	4,623,323	1909	25,795,471
1855	700,159	1883	4,595,510	1910	27,303,567
1856	788,515	1884	4,097,868	1911	23,649,547
1857	712,640	1885	4,044,526	1912	29,726,937
1858	629,548	1886	5,683,329	1913	30,966,152
1859	750,560	1887	6,417,148	1914	23,332,244
1860	821,223	1888	6,489,738	1915	29,916,213
1861	653,164	1889	7,603,642	1916	39,434,797
1862	703,270	1890	9,202,703	1917	38,621,216
1863	846,075	1891	8,279,870	1918	39,054,644
1864	1,014,282	1892	9,157,000		
1865	831,770	1893	7,124 502		667,015,268
1866	1,205,663				

FOREIGN TRADE IN PIG IRON.

IMPORTS.

The quantity of pig iron and ferroalloys, the principal of which were ferromanganese and ferrosilicon, imported into the United States in 1918 was 34,711 gross tons, compared with 76,786 tons imported in 1917, a decrease of 42,075 tons, or nearly 55 per cent. England and Canada furnished the largest quantity of these products in both years.

The statistics of imports of iron are compiled from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Pig iron, including kentledge, ferromanganese, ferrosilicon, and spiegeleisen, imported into the United States, 1914–1918, in gross tons.

Country.	1914	1915	1916	1917	1918
North America:					
Canada	25,968	21,166	33,716	21,143	5,692
Newfoundland and Labrador	200				
West Indies				83	
South America	250				
Europe:					
Austria-Hungary	899				
Belgium	500				
France	40	20			
Germany	10,609	600	341		
Italy	550			20	
Netherlands	2,539				
Norway	225				
Sweden	2,329	1,392	792		
Switzerland					
United Kingdom: England	90,627	59,105	89,764	51,384	28,392
United Kingdom: Scotland	1,012	792		250	
Asia:					
British India	1,310	2,382	1,313		501
China	200	3,430	8,861	3,503	
China, leased territory (British)	1,285				
Hongkong	200				
Japan	70	250	562	85	6
Oceania	90				
Other countries		699		318	120
	138,903	89,836	135,349	76,786	34,711

EXPORTS.

The quantity of pig iron exported from the United States in 1918 was 269,575 gross tons, compared with 656,220 tons in 1917, a decrease of 386,645 tons, or nearly 59 per cent. The decrease in value, from $24,037,051 in 1917, to $11,576,721 in 1918, represented nearly 52 per cent. The largest quantity was shipped in 1918 to Canada, and considerable quantities were shipped also to England and Italy, but exports to practically all foreign countries except Peru decreased notably. Several European countries that were added to the list in 1916, such as Switzerland, Denmark, Spain, and Sweden, imported no pig iron from the United States in 1918.

The following table has been compiled from records of the Bureau of Foreign and Domestic Commerce:

Pig iron exported from the United States to foreign countries, 1914–1918, in gross tons.

Country.	1914	1915	1916	1917	1918
North America:					
Canada	57,852	60,197	101,277	153,745	122,325
Costa Rica	18	50	68	26	
Mexico	454	684	676	920	297
Panama	1,056	2,316	1,968	1,816	881
West Indies:					
Cuba	593	844	5,338	4,243	892
South America:					
Argentina	1,042	912	380	2,580	129
Brazil	575	304	1,176	1,483	72
Chile	1,875	2,716	6,500	8,888	4,345
Peru	200	286	682	578	694
Europe:					
Austria-Hungary	1,150				
Belgium	1,219				
Denmark			17,380	1,836	
France	397	9,414	71,226	65,618	8,181
Germany	749				
Greece			50		
Italy	14,288	81,792	234,213	184,763	41,641
Netherlands	1,467	1,993	22,464	2,124	
Norway			11,267	12,986	1,000
Russia in Europe			926	6,017	

Pig iron exported from the United States to foreign countries, 1914–1918, in gross tons—Continued.

Country.	1914	1915	1916	1917	1918
Europe—Continued.					
Spain	....	....	8,464	5,891	....
Sweden	....	....	20,707	17,799	....
Switzerland	....	....	3,671	1,404	....
United Kingdom:					
England	18,013	57,368	88,315	138,196	66,197
Scotland	148	....	2,249	7,874	7,591
Ireland	....	....	357	1,610	313
Asia:					
Japan	2,938	1,811	5,033	30,809	11,986
Oceania:					
Australia	10,099	2,008	433	257	30
New Zealand	....	....	260	760	....
All other countries	290	1,814	2,156	3,997	3,001
	114,423	224,509	607,236	656,220	269,575
Value	$1,638,102	$3,667,167	$15,381,431	$24,037,051	$11,576,721

PRODUCTION OF PIG IRON IN PRINCIPAL COUNTRIES.

Data on the production of pig iron in certain countries of Europe have not been available for several years, but recently some estimates have been published and these together with official figures for other countries are compiled in the following table. Data for the year 1913 are included for comparison as showing the production in the last normal year and because the figures are more nearly complete for that year. In the chapter from Mineral Resources on iron ore in 1917 a table was given showing the pig iron produced in the principal countries of the world in 1850, 1890, 1900, 1901, 1910, 1913, 1915, and 1916, as published in Metal Statistics, New York, 1918. The figures for the last two years were largely estimated. The data were expressed in gross tons, but those in the following table are expressed in metric tons:

Pig iron produced in some principal countries, 1913–1918, in metric tons.

Country.	1913	1914	1915	1916	1917	1918	Source of data.[a]
United States	31,461,610	23,705,560	30,394,872	40,065,754	39,239,155	39,679,518	1913–1918, 1.
United Kingdom	10,424,480	9,066,553	8,863,137	9,062,181	9,487,514	9,184,060	1913–1917, 2; 1918, 3.
Germany	19,309,172	14,389,852	11,789,931	13,284,738	13,142,247	[b]11,758,967	1913–1918, 4.
France	5,207,197	4,500,000	1,300,000	1,447,000	1,684,023	1,261,670	1913, 5; 1914–1915, 6; 1916, 4; 1917–1918, 3.
Russia	4,634,889	4,326,519	3,690,300	3,737,593	(c)	(c)	1913–1914, 7, 1915–1916, 4.
Austria-Hungary	2,380,864	1,988,000	1,959,084	2,418,322	(c)	(c)	1913–1916, 4.
Belgium	2,484,690	1,454,490	68,150	127,825	7,990	(c)	1913–1917, 8.
Canada	1,024,192	710,482	828,971	1,060,743	1,061,852	1,083,190	1913–1918, 9.
Sweden	736,330	646,122	770,051	743,031	838,948	749,800	1913–1917, 10; 1918, 4.
Spain	424,774	382,044	439,835	501,667	357,699	386,550	1913–1918, 11.
Italy	426,755	385,340	377,510	467,005	471,188	(c)	1913–1917, 12.
Japan	240,288	300,155	317,964	385,647	(c)	(c)	1913–1916, 13.
Philippine Islands	227	199	96	93	(c)	(c)	1913–1916, 14.
India	(c)	238,482	274,347	250,498	255,491	268,898	1914–1918, 4.
Australia	47,308	76,352	77,539	128,616	148,762	(c)	1913–1918, 4.
China	(c)	(c)	(c)	148,400	144,815	(c)	1916–1917, 4.

[a] 1, American Iron and Steel Institute; 2, Mines and Quarries (London); 3, Iron Age; 4, National Federation of Iron and Steel Manufacturers (London); 5, Statistique de l'industrie minérale; 6, Iron Trade Review; 7, General review of the principal branches of the mining and metallurgical industries (Russia); 8, Statistique des industries extractives et métallurgiques; 9, Canada Dept. Mines, Mines Branch; 10, Bergshantering Sveriges Officiella Statistik; 11, Estadística minera de España; 12, Rivista del Servizio minerario; 13, Bur. Foreign and Domestic Commerce; 14, Mineral resources of the Philippine Islands.

[b] Excludes Lorraine, Sarre district, and Luxemburg for November and December.

[c] Statistics not available.

FERROALLOYS.

The manufacture of ferroalloys showed gains greater than in any other phase of the iron and steel industry in 1918. This condition was due to the continued strong demand for alloy steel for war purposes, coupled with the necessity for decreasing imports in order to conserve shipping space. Large quantities of ferromanganese were made by some of the consumers, and on account of the attractive prices many independent plants were built where electric power was available and at these plants a variety of alloys were made, including ferromanganese. It is generally considered, however, that under normal conditions ferromanganese can be made more economically in the blast furnace.

Shortage of foreign manganese ore and the forced use of leaner domestic ore necessitated certain changes in metallurgical practice, one of which was the reduction of the number of units of manganese in the standard alloy from 80 to 70 and in spiegeleisen from 20 to 16. After May 1, 1918, prices were based on the new standard.[1]

The utilization of spiegeleisen instead of ferromanganese in the manufacture of higher-carbon steels was encouraged.[2]

SHIPMENTS AND VALUE.

The output of ferroalloys in the United States is separated from that of pig iron in these compilations primarily in order to arrive at more nearly accurate values for these commodities. For instance, the quantity of ferroalloys of all classes reported as shipped or used (which the Survey is at liberty to publish) amounted to only about 1.96 per cent of the total marketed production of pig iron in 1918, but the price per ton was so much greater as to have an important influence on the apparent average price of the pig iron, and had it been included with the pig iron, it would have made the price $33.25 instead of $30.89 a ton. The quantity reported falls short of the actual production in the United States, as the output of certain electrically produced ferroalloys is not available for publication by the Geological Survey.

There is a sufficient number of producers of the commoner ferroalloys, such as ferromanganese, spiegeleisen, ferrotungsten, and ferrosilicon, to enable the Survey to publish the reported production of these four types of alloys separately; but the production of the rarer alloys, among which are ferrocerium, ferrochromium, ferromolybdenum, ferrotitanium, ferrozirconium, ferrovanadium, and ferrouranium, must be grouped together, and as there are less than three reporting producers of ferrophosphorus the value of this alloy is grouped with that of ferrosilicon.

The shipments of ferroalloys of all classes in 1918, as reported to the United States Geological Survey, were 750,868 gross tons, valued at $115,433,943, as compared with 634,021 gross tons, valued at $83,731,724, in 1917, an increase in quantity of 116,847 tons, or 18.4 per cent, and in value of $31,702,219, or 37.9 per cent, in 1918. Of the shipments in 1918, it is calculated that 273,372 gross tons, valued at $61,892,342, were made from imported ores derived from Argentina, Bolivia, Brazil, British Columbia, Chile, China, Costa Rica, Cuba, Guatemala, India, Japan, Mexico, New Caledonia, Panama, Peru, Porto Rico, and Quebec. The ferrovanadium, ferromolybdenum, ferromanganese, spiegeleisen, ferrotungsten, ferrochromium, ferrotitanium, and ferrozirconium were made in part or wholly from imported ore.

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[1] Iron Trade Review, Jan. 2, 1919, pp. 118-120.
[2] Hall, J. H., Phases of iron and steel metallurgy in 1918: Iron Age, Jan. 1, 1919, p. 27.

The reported sales of ferromanganese and spiegeleisen of domestic manufacture in 1918 amounted to 569,937 gross tons, valued at $86,322,172, compared with 449,466 gross tons, valued at $63,687,007, sold in 1917. The figures for ferromanganese and spiegeleisen are as follows: For 1918, ferromanganese 306,076 gross tons, valued at $69,045,678, or an average of $225.58 a ton, compared with 260,225 gross tons, valued at $53,930,771, or an average of $207.25 a ton in 1917, an increase in quantity of 17.6 per cent and in total value of 28 per cent. For 1918, spiegeleisen 263,861 gross tons, valued at $17,276,494, or $65.48 a ton, compared with 189,241 gross tons, valued at $9,756,236, or an average of $51.55 a ton in 1917, an increase in quantity of 39.4 per cent and in total value of 77 per cent. The continued increases in value are noteworthy. The reported sales of ferrosilicon and ferrophosphorus in 1918 amounted to 171,756 gross tons, valued at $11,864,904, an average of 69.08 a ton, compared with 175,079 gross tons, valued at $8,562,182, or $48.90 a ton, in 1917. Included in the ferrosilicon shipments were 30,617 gross tons of 50 per cent ferrosilicon, valued at $4,458,626, but it is believed that this quantity falls far short of that actually produced and marketed. The sales of alloys of iron with the rarer metals—chromium, cerium, molybdenum, tungsten, titanium, zirconium, uranium, and vanadium—as reported to the Survey, amounted in 1918 to 9,175 gross tons, valued at $17,246,867, compared with 9,476 gross tons, valued at $11,482,535, in 1917, a decrease in quantity of 301 tons but an increase in value of $5,764,332. These alloys were therefore valued at an average price of nearly $1,880 a ton in 1918, compared with $1,212 a ton in 1917. Ferrotungsten shipments in 1918 were 2,142 gross tons, valued at $7,798,898, or an average of nearly $3,641 a ton.

The following tables give an incomplete outline of the shipments of ferroalloys in the United States in 1914, 1915, 1916, 1917, and 1918:

Ferroalloys of domestic manufacture shipped, 1914–1918.

Variety of alloy.	1914		1915		1916	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Ferromanganese	100,731	$4,440,253	144,260	$9,253,443	224,103	$30,123,493
Spiegeleisen	76,625	1,586,139	114,556	2,403,550	182,837	6,158,202
Ferrosilicon	77,182	1,621,830	128,263	2,595,265	166,308	5,273,088
Ferrophosphorus					12,966	
Ferrotungsten (50 per cent or more tungsten)	(a)	(a)	(a)	(a)	(a)	(a)
Other varieties[b]	986	1,702,023	1,565	3,198,127	3,524	8,726,909
	255,524	9,350,245	388,644	17,450,385	589,738	50,281,692

Variety of alloy.	1917		1918	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Ferromanganese	260,225	$53,930,771	306,076	$69,045,678
Spiegeleisen	189,241	9,756,236	263,861	17,276,494
Ferrosilicon	175,079	8,562,182	171,756	11,864,904
Ferrophosphorus				
Ferrotungsten (50 per cent or more tungsten)	1,258	4,225,070	2,142	7,798,898
Other varieties[b]	8,218	7,257,465	7,033	9,447,969
	634,021	83,731,724	750,868	115,433,943

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[a] Included with "Other varieties."

[b] 1914 and 1915: Ferromolybdenum, ferrotungsten, and ferrovanadium; 1916: Ferrochrome, ferromolybdenum, ferrotungsten, and ferrovanadium; 1917: Ferrocerium, ferrochrome, ferromolybdenum, ferrocarbontitanium, ferrouranium, and ferrovanadium; 1918: Ferrocarbontitanium, ferrocerium, ferrochrome, ferromolybdenum, ferrotitanium, ferrouranium, ferrovanadium, and ferrozirconium.

Ferroalloys of domestic manufacture shipped in 1911–1918, in gross tons.

Year.	Ferromanangese.	Spiegeleisen.	Other varieties.	Total quantity.	Total value.
1911	178,615		74,760	253,375	$8,377,832
1912	227,939		100,746	328,685	12,223,776
1913	119,495	106,980	69,732	296,207	13,015,362
1914	100,731	76,625	78,168	255,524	9,350,245
1915	144,260	114,556	129,828	388,644	17,450,385
1916	224,103	182,837	182,798	589,738	50,281,692
1917	260,225	189,241	184,555	634,021	83,731,724
1918	306,076	263,861	180,931	750,868	115,433,943

In 1918 ferromanganese was reported to have been made at 28 localities in the United States, spiegeleisen at 19 places, ferrosilicon at 20 places, ferrophosphorus at 1 place, ferrocerium at 1 place, ferrochromium at 4 places, ferromolybdenum at 2 places, ferrotitanium at 2 places, ferrotungsten at 8 places, ferrouranium at 1 place, ferrozirconium at 1 place, and ferrovanadium at 6 places.

The following table shows the number of localities by States at which the principal ferroalloys were manufactured in 1916, 1917, and 1918, but these operations do not include all those at which ferroalloys were manufactured electrically. In many places, of course, several alloys were made at the same plant. In all there were reported 61 localities at which ferroalloys were made in 1918, compared with 52 in 1917.

Number of places, by States, at which ferroalloys were manufactured in 1916, 1917, and 1918.

State and alloy.	1916	1917	1918
Alabama:			
Ferromanganese	2	3	3
Spiegeleisen	2	3	3
California:			
Ferromanganese	1	1	2
Ferrosilicon	0	1	1
Ferrochromium	1	1	0
Ferromolybdenum	0	1	0
Ferrotungsten	0	1	0
Colorado:			
Spiegeleisen	1	1	1
Ferrosilicon	0	1	1
Ferrochromium	0	1	1
Ferromolybdenum	0	1	0
Ferrotungsten	0	2	2
Illinois:			
Ferromanganese	2	2	1
Spiegeleisen	1	2	1
Ferrosilicon	1	0	0
Iowa:			
Ferrosilicon	1	1	1
Kentucky:			
Ferrosilicon	1	1	0
Maryland:			
Ferromanganese	1	1	0
Ferrochromium	0	0	1
Ferrosilicon	1	1	1
Ferrotungsten	0	1	1
Spiegeleisen	1	0	0
Montana:			
Ferromanganese	0	0	1
New Jersey:			
Ferromanganese	0	1	1
Ferrochromium	0	0	1
New Jersey—Continued.			
Ferrotungsten	0	0	1
Ferrotitanium	0	0	1
Ferrozirconium	0	0	1
Ferrovanadium	0	0	1
New York:			
Ferromanganese	0	1	2
Ferrosilicon	1	5	8
Ferrotitanium	0	1	1
Ferrotungsten	0	1	1
Ohio:			
Ferrosilicon	4	4	4
Oregon:			
Ferromanganese	0	1	1
Pennsylvania:			
Ferromanganese	8	9	12
Spiegeleisen	7	9	11
Ferrosilicon	1	1	1
Ferrocerium	0	1	1
Ferrochromium	0	1	1
Ferromolybdenum	1	1	2
Ferrotungsten	3	3	3
Ferrouranium	0	1	1
Ferrovanadium	3	4	5
Tennessee:			
Ferrosilicon	0	2	3
Ferrophosphorus	2	1	1
Virginia:			
Ferromanganese	0	2	3
Spiegeleisen	0	3	3
Washington:			
Ferromanganese	0	2	2
Ferrochromium	0	1	0

The following records of average contract prices of ferromanganese at eastern seaboard and of spiegeleisen at furnaces by months for the last four years are of interest. Prices on ferromanganese prior to May, 1918, are based on 80 per cent manganese and succeeding prices on 70 per cent metal; prices on spiegeleisen prior to May, 1918, are based on 20 per cent manganese, and succeeding prices on 16 per cent metal.

Prices per ton of ferromanganese and spiegeleisen, 1915, 1916, 1917, and 1918.[a]

Month.	Ferromanganese.				Spiegeleisen.			
	1915	1916	1917	1918	1915	1916	1917	1918
January	$68.00	$110.00	$175.00	$250.00	$25.00	$32.50	$57.50	$59.00
February	100.00	140.00	192.50	250.00	25.50	42.50	66.25	59.00
March	100.00	175.00	212.50	250.00	26.00	55.00	77.50	65.50
April	100.00	175.00	250.00	250.00	26.00	60.00	76.75	70.00
May	100.00	175.00	375.00	250.00	26.00	60.00	78.00	71.00
June	105.00	175.00	400.00	250.00	26.00	55.00	83.00	75.00
July	103.00	175.00	400.00	250.00	26.00	47.50	85.00	75.00
August	105.00	170.00	387.50	250.00	26.00	47.50	81.25	75.00
September	110.00	164.00	380.00	250.00	29.00	45.00	80.50	75.00
October	105.00	160.00	300.00	250.00	30.00	40.00	73.50	75.00
November	100.00	155.00	247.50	250.00	30.00	45.00	63.25	75.00
December	100.00	162.50	247.50	250.00	30.00	50.00	60.00	72.50

[a] Iron Trade Review, Jan. 2, 1919, p. 120.

IMPORTS.

According to the reports of the Bureau of Foreign and Domestic Commerce, the imports of all classes of ferroalloys for consumption into the United States in 1918 were 34,719 gross tons, valued at $4,932,042, compared with 55,763 tons, valued at $6,703,330 in 1917. The imports of ferromanganese were 27,168 gross tons, valued at $4,258,745, or $156.76 a ton, as compared with 41,969 gross tons, valued at $5,710,988, or $136.08 a ton, in 1917. The imports of spiegeleisen in 1918 amounted to 1,969 gross tons, valued at $228,012, or $115.80 a ton, as compared with 3,968 gross tons, valued at $291,594, or $73.48 a ton, in 1917. These values declared on the imports do not correspond very closely with the averages or ranges in market value, ferromanganese being low and spiegeleisen high. The imports of the alloys of the rarer metals are not all reported separately. For instance, the imports of ferrochromium are combined with those of chromium, those of ferromolybdenum are combined with those of the metal molybdenum, and those of ferrotungsten are included with those of tungsten. For the sake of comparison, however, such statistics as are available are presented in the following two tables:

Ferroalloys imported for consumption in the United States, 1914–1918.

Variety of alloy.	1914		1915		1916	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Chrome or chromium and ferrochrome	200	$21,553	32	$1,662	10	$1,998
Ferrophosphorus	26	1,136	12	617		
Ferrosilicon	6,249	341,925	5,128	311,219	6,740	384,384
Molybdenum and ferromolybdenum	.10	59		203		
Titanium and ferrotitanium	18	8,356			100	8,126
Tungsten and ferrotungsten	195	222,447	7	9,588	38	157,711
Ferromanganese	82,997	3,619,607	55,263	3,333,699	90,928	9,240,528
Spiegeleisen	2,870	71,147	200	5,110		
	92,555.10	4,286,230	60,642	3,662,098	97,816	9,792,747

Variety of alloy.	1917		1918	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Ferrophosphorus	85	$5,458	10	$1,055
Ferrosilicon	9,740	691,684	5,540	424,932
Molybdenum and ferromolybdenum			32	19,280
Titanium and ferrotitanium			(a)	10
Tungsten and ferrotungsten	1	3,606		8
Ferromanganese	41,969	5,710,988	27,168	4,258,745
Spiegeleisen	3,968	291,594	1,969	228,012
	55,763	6,703,330	34,719	4,932,042

[a] 10 pounds.

Ferromanganese and ferrosilicon imported into the United States in 1916, 1917, and 1918, by countries.

[General imports.]

Country.	Alloy.	1916		1917		1918	
		Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
British India	Ferromanganese	[a] 1,313	$190,649				
Canada	Ferrosilicon	6,691	379,133	9,729	$689,902		
England	Ferromanganese	[a] 41,832	4,626,509	45,059	6,054,188	27,162	$4,257,501
	Ferrosilicon	49	5,251				
Scotland	Ferromanganese			250	38,932		
Japan	Ferromanganese			72	14,259	6	1,244
	Ferrosilicon			11	1,782	5,540	424,932

[a] Figures cover six months, July to December; included in "All other pig iron" prior to July, 1916.

PRODUCTION OF STEEL, BY STATES AND KINDS.

The following tables showing the production of steel were compiled by the bureau of statistics of the American Iron and Steel Institute. No data whatever are available on the value of the output of crude steel at the mills, but the weekly issues and annual statistical reviews of the Iron Age give market quotations of prices of steel billets and of some of the leading forms of finished steel. The price of Bessemer steel billets at Pittsburgh during the war ranged between $19 a gross ton in June, 1914, and $100 in July, 1917, but while under Government control the price was stationary at $47.50 during 1918. Tank plates ranged from 1.05 cents a pound in December, 1914, to 9 cents in July, 1917; the Government price in 1918 was 3.25 cents a pound. Steel beams at Pittsburgh ranged from 1.07 cents a pound in December, 1914, to 4.5 cents in 1917, and were priced by the Government at 3 cents during 1918.

Bessemer steel ingots and castings manufactured in the United States, 1914–1918, in gross tons.

State.	1914	1915	1916	1917	1918
Ohio	2,862,700	3,929,665	4,711,784	4,256,337	3,920,442
Pennsylvania	2,014,526	2,507,243	3,444,163	3,537,094	3,281,941
Illinois	871,110	1,270,502	1,958,259	1,683,960	1,079,927
Other States	472,510	579,803	944,833	1,002,569	1,093,926
	6,220,846	8,287,213	11,059,039	10,479,960	9,376,236

Open-hearth steel ingots and castings manufactured in the United States, 1914–1918, in gross tons.

State.	1914	1915	1916	1917	1918
New England States	137,962	191,582	278,768	332,597	329,630
New York and New Jersey	719,227	1,266,017	1,872,258	2,110,846	2,245,239
Pennsylvania	9,854,038	13,245,393	16,030,251	16,284,102	15,574,101
Ohio	2,592,778	3,521,404	5,057,751	6,074,857	6,729,955
Indiana	1,628,840	2,504,427	3,243,961	3,722,931	3,910,899
Illinois	896,610	1,169,657	1,812,169	1,966,296	2,283,991
Other States	1,345,229	1,780,622	3,120,269	3,657,264	3,385,576
	17,174,684	23,679,102	31,415,427	34,148,893	34,459,391

According to these tables there was a decrease of nearly 11 per cent in the production of Bessemer steel in 1918 compared with that of 1917, and an increase of 0.9 per cent in open-hearth steel. In the total production of steel in 1918 there was a decrease of 1.3 per cent compared with 1917. Of the total output in 1918, nearly 78 per cent was represented by open-hearth steel, 21 per cent by Bessemer steel, and more than 1 per cent by all other classes of steel.

PRODUCTION OF ELECTRIC STEEL.

The production of steel by the electric process in 1918 amounted to 511,364 gross tons, as compared with 304,543 tons in 1917, an increase of 206,821 tons, or 68 per cent. The following table gives the production of electric steel ingots and castings since 1909. In 1908 there were 55 tons of electric steel produced, but this quantity was included with open-hearth steel for that year.

Steel electrically manufactured in the United States, 1909 to 1918, in gross tons.

Year.	Ingots.	Castings.	Total.
1909	13,456	306	13,762
1910	50,821	1,320	52,141
1911	27,227	1,878	29,105
1912	14,147	4,162	18,309
1913	20,973	9,207	30,180
1914	15,458	8,551	24,009
1915	46,348	23,064	69,412
1916	126,048	42,870	168,918
1917	239,632	64,911	304,543
1918	403,068	108,296	511,364

In the total production of electric steel in 1918 are included 290,961 tons of steel ingots and castings which were treated with ferrovanadium, ferrotitanium, ferrochromium, and other alloys, of which 287,885 tons were ingots and 3,076 were castings, compared with 130,578 tons—129,282 tons of ingots and 1,296 tons of castings—so treated in 1917.

On December 31, 1918, the number of completed plants which were equipped for the manufacture of steel by the electric process was 126, as compared with 89 plants at the close of 1917, a gain of 37 plants. On January 1, 1918, it is reported that there were 233 electric furnaces of all types in the United States and 36 in Canada, and at the end of the year these totals had increased to 330 in the United States and 43 in Canada. The total number of furnaces in the world at the beginning and end of 1918 was estimated at 733 and about 815, respectively, as compared with 140 in 1913.[1]

TOTAL DOMESTIC PRODUCTION OF STEEL.

At the beginning of 1918 the annual capacity of the United States for producing steel ingots was considered to be between 46,000,000 and 48,000,000 gross tons, and during the year 1918 this capacity is estimated to have been increased nearly 2,000,000 tons, bringing the capacity on January 1, 1919, up to between 48,000,000 and 50,000,000 tons. This domestic capacity is estimated to comprise about 48 per cent of the world's total facilities for making steel.[2]

The maximum possible capacity is usually reckoned on the basis of the most favorable conditions of manufacture, transportation, and markets, so that in practice the maximum output usually falls short of the rated capacity by 5 per cent or more. In 1917 conditions were especially favorable and the output of 45,060,607 gross tons was close to the physical capacity of the steel furnaces then in existence. Despite an increase in equipment of nearly 2,000,000 tons capacity the actual output in 1918 amounted to 44,462,432 gross tons of crude steel, which represents a decrease of 1.3 per cent as compared with 1917.

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[1] Cone, E. F., The status of the electric steel industry: Iron Age, Jan. 2, 1919, pp. 60-62.

[2] Sawhill, R. V., Steel capacity is 50,000,000 tons: Iron Trade Rev., Jan. 2, 1919, pp. 78-79. New iron and steel works construction: Iron Age, Jan. 2, 1919, pp. 64-71, 89-91. Benner, S. A., Prospects for world trade in steel: Iron Trade Review, Jan 2, 1919, pp. 25-27.

Steel produced in the United States, 1810–1918, in gross tons.

Year.	Bessemer.	Open-hearth.	Crucible.	Other steel.	Total.
1810	....	....	917		917
1860	....	....	11,838		11,838
1863	....	....	8,075		8,075
1864	....	....	9,258		9,258
1865	....	....	13,627		13,627
1866	....	....	16,940		16,940
1867	2,679	....	16,964		19,643
1868	7,589	....	19,197		26,786
1869	10,714	893	19,643		31,250
1870	37,500	1,339	29,911		68,750
1871	40,179	1,785	31,250		73,214
1872	107,239	2,679	26,125	6,911	142,954
1873	152,368	3,125	31,059	12,244	198,796
1874	171,369	6,250	32,436	5,672	215,727
1875	335,283	8,080	35,180	11,256	389,799
1876	469,639	19,187	35,163	9,202	533,191
1877	500,524	22,349	36,098	10,647	569,618
1878	653,773	32,255	38,309	7,640	731,977
1879	829,439	50,259	50,696	4,879	935,273
1880	1,074,262	100,851	64,664	7,558	1,247,335
1881	1,374,247	131,202	80,145	2,720	1,588,314
1882	1,514,687	143,341	75,973	2,691	1,736,692
1883	1,477,345	119,356	71,835	4,999	1,673,535
1884	1,375,531	117,515	53,270	4,563	1,550,879
1885	1,519,430	133,376	57,599	1,515	1,711,920
1886	2,269,190	218,973	71,973	2,367	2,562,503
1887	2,936,033	322,069	75,375	5,594	3,339,071
1888	2,511,161	314,318	70,279	3,682	2,899,440
1889	2,930,204	374,543	75,865	5,120	3,385,732
1890	3,688,871	513,232	71,175	3,793	4,277,071
1891	3,247,417	579,753	72,586	4,484	3,904,240
1892	4,168,435	669,889	84,709	4,548	4,927,581
1893	3,215,686	737,890	63,613	2,806	4,019,995
1894	3,571,313	784,936	51,702	4,081	4,412,032
1895	4,909,128	1,137,182	67,666	858	6,114,834
1896	3,919,906	1,298,700	60,689	2,394	5,281,689
1897	5,475,315	1,608,671	69,959	3,012	7,156,957
1898	6,609,017	2,230,292	89,747	3,801	8,932,857
1899	7,586,354	2,947,316	101,213	4,974	10,639,857
1900	6,684,770	3,398,135	100,562	4,862	10,188,329
1901	8,713,302	4,656,309	98,513	5,471	13,473,595
1902	9,138,363	5,687,729	112,772	8,386	14,947,250
1903	8,592,829	5,829,911	102,434	9,804	14,534,978
1904	7,859,140	5,908,166	83,391	9,190	13,859,887
1905	10,941,375	8,971,376	102,233	8,963	20,023,947
1906	12,275,830	10,980,413	127,513	14,380	23,398,136
1907	11,667,549	11,549,736	131,234	14,075	23,362,594
1908	6,116,755	7,836,729	63,631	6,132	14,023,247
1909	9,330,783	14,493,936	107,355	22,947	23,955,021
1910	9,412,772	16,504,509	122,303	55,335	26,094,919
1911	7,947,854	15,598,650	97,653	31,949	23,676,106
1912	10,327,901	20,780,723	121,517	21,162	31,251,303
1913	9,545,706	21,599,931	121,226	34,011	31,300,874
1914	6,220,846	17,174,684	89,869	27,631	23,513,030
1915	8,287,213	23,679,102	113,782	70,939	32,151,036
1916	11,059,039	31,415,427	129,692	169,522	42,773,680
1917	10,479,960	34,148,893	126,716	305,038	45,060,607
1918	9,376,236	34,459,391	115,112	511,693	44,462,432

FOREIGN TRADE IN STEEL.

The development of the export trade in steel in the United States since the beginning of the war in Europe is indicated in the table of exports which shows, by classes, the exports of manufactured iron and steel from this country in 1914, 1915, 1916, 1917, and 1918. For comparison the imports are tabulated also. The figures were compiled from records of the Bureau of Foreign and Domestic Commerce.

In 1915, 1916, and 1917 the quantity of iron and steel exports (so far as recorded) increased 149 per cent, 66 per cent, and 5 per cent, respectively, but in 1918 the quantity decreased 12 per cent. The total values increased 133 per cent, 136 per cent, and 57 per cent, respectively, in 1915, 1916, and 1917, but decreased 1 per cent in 1918. The stringency in shipping facilities and the war needs of the United States in 1917 and 1918 are responsible for the nearly stationary condition of the export trade in those years.

Iron and steel imported into the United States, 1914–1918.

Article.	1914		1915		1916	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Scrap iron and steel	34,839	$277,818	79,982	$761,719	116,039	$1,140,704
Bar iron	15,015	625,365	8,474	417,491	7,701	647,393
Ingots, blooms, slabs, etc., not elsewhere specified	2,099	57,682	4,412	187,623	11,487	430,323
Ingots, blooms, and slabs, billets and bars of steel, and steel in forms, not elsewhere specified	38,090	2,885,365	10,586	1,753,978	17,792	2,809,319
Hoop or band iron or steel for baling	[a] 648	23,702		28		
Rails for railway	22,571	610,037	78,525	2,068,532	26,299	740,109
Sheets and plates	4,310	514,080	1,420	218,954	1,938	345,622
Tin and terne plates	15,411	1,049,297	2,350	196,328	1,129	214,574
Wire rods	6,954	373,615	5,317	331,724	4,625	509,559
	139,937	6,416,961	191,066	5,956,377	187,010	6,837,603
Wire and articles made from wire		1,205,456		640,521		652,889
All other manufactures: free		406,673		200,763		105,896
All other manufactures: dutiable		3,674,401		2,324,447		3,502,219
		5,286,530		3,165,731		4,261,004
Grand total		11,703,491		9,122,108		11,098,607

Article.	1917		1918	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Scrap iron and steel	180,034	$2,437,423	63,730	$1,221,752
Bar iron	2,240	193,831	1,469	194,597
Ingots, blooms, slabs, etc., not elsewhere specified	35,861	1,635,323	33,612	1,550,175
Ingots, blooms, and slabs, billets and bars of steel, and steel in forms, not elsewhere specified	8,337	2,313,613	1,415	167,050
Rails for railway	9,263	307,139	8,705	341,985
Sheets and plates	1,747	526,788	1,517	632,558
Tin and terne plates	124	31,453	32	5,964
Wire rods	1,060	221,184	7,677	621,936
	238,666	7,666,754	118,157	4,736,017
Wire and articles made from wire		348,876		273,705
All other manufactures: free		82,993		551,304
All other manufactures: dutiable		4,072,935		4,807,597
		4,504,804		5,632,606
Grand total		12,171,558		10,368,623

[a] Figures cover six months, July to December.

Iron and steel exported from the United States, 1914–1918.

Article.	1914		1915		1916	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Scrap and old, fit only for manufacture	33,134	$386,208	79,361	$1,111,254	212,765	$3,689,675
Bar iron	5,226	203,835	39,740	1,471,466	74,069	3,913,849
Bars or rods (of steel), wire rods	61,856	1,810,389	165,015	4,713,109	158,284	8,109,111
All other	123,008	4,612,197	425,678	16,412,440	774,455	47,670,406
Billets, ingots, and blooms, not elsewhere specified	50,496	1,103,702	560,704	14,176,528	1,504,562	90,095,601
Bolts and nuts	15,127	1,234,440	23,536	1,896,842	29,227	3,132,897
Hoop and bands	9,954	457,451	29,249	1,433,879	43,208	3,251,882
Horseshoes	5,903	748,136	15,863	2,741,724	7,806	1,007,198
Cut nails	3,423	142,285	4,236	190,667	4,752	312,195
Railroad spikes	6,915	258,808	13,256	591,752	23,852	1,489,091
Wire nails	36,124	1,603,904	91,584	4,371,072	150,173	10,794,418
All other (including tacks)	3,183	401,319	9,251	1,085,416	12,353	1,637,051
Cast-iron pipes and fittings	38,418	1,462,670	47,022	2,128,025	70,223	3,988,293
Wrought-iron pipes and fittings	56,717	3,355,120	120,966	8,081,416	158,350	13,195,696
Radiators and cast-iron house-heating boilers	3,572	278,775	2,291	183,523	2,424	232,845
Rails for railways, of steel	174,680	5,103,918	391,379	12,095,170	540,828	20,417,582
Galvanized iron and steel plates	40,463	2,723,971	75,905	5,381,303	85,304	8,350,005
Iron sheets and plates, all other	7,555	404,213	25,543	1,221,699	46,499	3,136,262
Steel plates	111,642	4,198,106	223,806	8,037,551	276,034	16,499,757
Steel sheets	120,436	5,110,206	94,349	3,726,933	107,721	6,546,814
Structural iron and steel	182,395	6,961,636	232,139	8,960,411	300,594	17,541,862
Tin and terne plates	59,549	4,337,779	154,641	11,501,995	227,391	21,352,177
Barbed wire	93,846	4,633,348	248,611	13,933,234	418,882	31,230,905
All other wire	87,022	3,935,241	224,972	11,900,373	264,142	20,994,035
	1,330,644	55,467,657	3,308,097	137,347,782	5,493,898	338,589,607
Axes	....	751,313	....	588,443	....	722,520
Hammers and hatchets	....	265,682	....	509,824	....	366,161
Railway-track material, switches, frogs, fishplates, splices, bars, etc.	....	1,775,391	....	4,857,047	....	6,540,187
Saws	....	1,158,122	....	1,294,447	....	2,923,055
Shovels and spades	....	263,733	....	352,727	....	666,407
All other tools	....	6,306,382	....	8,676,483	....	12,716,778
	....	10,520,623	....	16,278,971	....	23,935,108
Grand total	....	65,988,280	....	153,626,753	....	362,524,715

Iron and steel exported from the United States, 1914–1918—Continued.

Article.	1917		1918	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Scrap and old, fit only for manufacture	145,574	$3,362,562	2,160	$63,626
Bar iron	56,332	5,046,727	63,367	6,576,362
Bars or rods (of steel), wire rods	181,941	15,356,275	148,524	12,469,715
All other	626,465	59,703,761	579,250	64,575,140
Billets, ingots, and blooms, not elsewhere specified	2,017,113	161,391,007	1,786,189	150,568,151
Bolts and nuts	32,261	5,259,622	28,333	5,687,998
Hoop and bands	58,769	7,330,301	50,673	7,711,195
Horseshoes	8,403	1,594,952	2,857	424,208
Cut nails	4,525	434,736	3,823	440,281
Railroad spikes	21,188	2,009,808	4,649	600,174
Wire nails	114,912	12,088,147	78,726	9,921,123
All other (including tacks)	19,351	3,867,605	11,792	3,336,570
Cast-iron pipes and fittings	77,528	7,483,216	55,961	6,665,597
Wrought-iron pipes and fittings	127,191	16,659,553	89,982	14,993,957
Radiators and cast-iron house-heating boilers	5,201	672,331	2,857	548,800
Rails for railways, of steel	512,669	24,023,090	453,537	26,402,864
Galvanized iron and steel plates	86,487	13,207,827	68,742	12,609,628
Iron sheets and plates, all other	62,238	7,540,780	40,756	6,315,095
Steel plates	525,660	65,888,695	551,967	64,678,628
Steel sheets	157,354	18,654,553	150,028	25,646,749
Structural iron and steel	294,150	24,437,289	232,792	21,468,452
Tin and terne plates	232,797	41,888,418	258,538	55,850,294
Barbed wire	193,471	19,775,784	235,083	23,492,540
All other wire	201,472	22,541,224	157,222	20,704,503
	5,763,052	540,218,263	5,057,808	541,751,650
Axes	....	1,023,184	....	1,006,848
Hammers and hatchets	....	568,892	....	484,670
Railway-track material, switches, frogs, fishplates, splices, bars, etc	....	8,194,270	....	5,546,969
Saws	....	5,113,514	....	3,790,416
Shovels and spades	....	509,559	....	680,591
All other tools	....	14,096,939	....	9,140,700
	....	29,506,358	....	20,650,194
Grand total	....	569,724,621	....	562,401,844

PRODUCTION OF STEEL IN PRINCIPAL COUNTRIES.

Such data as are at hand on the production of steel in the principal countries of the world from 1913 to 1918 are shown in the following table. The data are, of course, incomplete on account of the war and because official statistics for most countries for 1918 are not yet available. The figures have been compiled from a variety of sources, but all have been reduced to the common unit, the metric ton.

Steel produced in some principal countries, 1913–1918, in metric tons.

Country.	1913	1914	1915	1916	1917	1918	Source of data.[a]
United States	31,801,688	23,889,238	32,665,453	43,458,059	45,781,577	45,173,831	1913–1918, 1.
United Kingdom	7,786,498	7,960,475	8,686,815	9,343,600	9,960,944	9,744,891	1913–1918, 2.
Germany	18,935,089	14,946,212	13,258,054	16,182,520	16,587,360	[b]14,875,753	1913–1918, 2.
France	4,686,866	3,250,000	870,000	1,952,000	2,231,651	1,809,771	1913, 3; 1914–1915, 4; 1916, 2; 1917–1918, 5.
Russia	4,868,140	4,782,965	4,900,000	(c)	(c)	(c)	1913–1914, 6; 1915, 2.
Austria-Hungary	2,625,879	2,160,239	2,674,197	3,330,306	2,920,789	1,763,745	1913–1916, 2; 1917–1918, 7.
Canada	1,060,503	751,738	926,151	1,295,699	1,583,719	1,717,318	1913–1918, 8.
Sweden	590,887	507,332	600,418	614,111	581,000	524,800	1913–1917, 9; 1918, 2.
Italy	933,500	911,000	1,009,240	1,269,486	1,331,641	(c)	1913–1917, 10.
India	(c)	67,669	105,130	133,189	165,314	185,186	1914–1918, 2.
Australia	(c)	24,811	63,349	110,144	158,121	(c)	1914–1917, 2.
Belgium	2,466,630	1,396,300	98,820	99,371	9,530	10,540	1913–1918, 11.
Japan	254,951	282,504	342,865	368,395	(c)	(c)	1913–1916, 12.

[a] 1, American Iron and Steel Institute; 2, National Federation of Iron and Steel Manufacturers (London); 3, Statistique de l'industrie minérale; 4, Iron Trade Review; 5, Iron Age; 6, General review of the principal branches of the mining and metallurgical industries (Russia); 7, Ironmonger; 8, Canada Dept. of Mines, Mines Branch; 9, Bergshantering Sveriges Officiella Statistik; 10, Rivista del Servizio minerario; 11, Statistique des industries extractives et métallurgiques; 12, Bur. Foreign and Domestic Commerce.

[b] Excludes Lorraine, Sarre district, and Luxemburg for November and December.

[c] Statistics not available.

IRON AND STEEL INDUSTRY IN RELATION TO THE WAR.

The part played by the American iron and steel industry during the world war was so vitally important to the success of the cause of the Allies that a brief review of the outstanding features during this whole period is submitted here.

For a few months prior to the beginning of the war, indeed, during nearly the whole of the year 1914, the iron industry was in a stage of stagnation. Prices were low; there was but little domestic or foreign demand for iron and steel, and that little demand was easily met by the operations of mines and furnaces at a greatly reduced rate of output compared with that of the two preceding years, In fact, many companies that could have saved money by closing their mines and furnaces generously kept them in operation to an extent sufficient to support part of the army of people dependent on the wages earned in normal times.

The first effect of the world war on the financial situation in the United States was such as still further to discourage the buying of iron and steel products and to depress prices. This condition, of course, could not well be other than temporary, for the interference of war with industries in certain of the belligerent countries could not fail to reduce the output of their mines and furnaces and to enlarge the demand for American iron and steel. It then seemed probable that domestic markets on the Pacific coast, formerly supplied in large part by manufacturers in England, Belgium, and Germany, would become open to American manufacturers, as well as markets in Canada, South America, and Japan. Such trade revivals and readjustments require time for their accomplishment even under the impetus of war conditions, and it was not until the middle of 1915, or until the war had been in progress nearly a year, that the demand for iron ores and metals had become general throughout the United States.

IRON ORE.

As soon as the demand for iron ore became heavy, about the middle of 1915, it met with a ready response, particularly in the Lake Superior district, where there was an increase in shipments of nearly 45 per cent in 1915, compared with an aggregate increase of about 12 per cent in the other iron-mining districts of the United States. In 1916 the heavy movement of ore began as soon as navigation opened, with the result that more than 66,600,000 gross tons was shipped from the Lake district, an increase of nearly 41 per cent. The total shipments for the United States in 1916 amounted to about 77,800,000 tons, an increase for the whole country of about 40 per cent. In 1917 the total iron-ore shipments were about 75,500,000 gross tons, a decrease of nearly 3 per cent from 1916, and in 1918 they were about 72,000,000 tons, a decrease of 4.7 from the shipments in 1917. In the last two years the Lake Superior district shipped approximately 64,400,000 and 62,800,000 tons, respectively, or slight decreases from the record year 1916. Stocks of ore at mines were maintained at more than 13,000,000 tons in 1914 and 1915; in 1916 and 1917 they amounted to about 11,000,000 tons; but in 1918 they dropped to less than 8,500,000 tons as a result of decrease in production.

The general average prices of iron ore per ton at the mines for the whole United States were $1.81 in 1914, $1.83 in 1915, $2.34 in 1916,

$3.15 in 1917, and $3.39 in 1918, a general increase of about 87 per cent during the war. For the season of 1914 the base selling prices of Lake Superior ore at Lake Erie ports ranged from $2.85 per ton for Mesabi non-Bessemer to $3.75 per ton for old range Bessemer. For the season of 1916 these prices were advanced 70 to 75 cents a ton; for the season of 1917 there was a general advance of $1.50 a ton; and for 1918 there were two increases, aggregating 70 cents a ton, which brought the prices up to $5.75 to $6.65 a ton. The total increases thus ranged from 102 to 77 per cent during the war period.

The available supply of iron ore is of course of fundamental importance. It was pointed out by the Geological Survey at the beginning of the war that the iron-ore reserves in the United States are so huge that mining operations (so far as the available ore is concerned) can readily respond to an increased demand for ore. The great increase in output of ore during 1915 and 1916, the sustained high production in 1917 and 1918, and the progress made in developing new ore bodies bears out this statement. The chief limitations to output of iron ore in the Lake Superior region were those imposed by shortage of labor and transportation facilities. Notwithstanding the great drain on the iron-ore reserves (shipments, amounted in the four years 1915–1918, to more than 241,000,000 tons from the Lake Superior district alone) new discoveries of ore in that district nearly kept pace with production so that at the close of the war there appeared to be within about 40,000,000 tons of the quantity of ore known to be available at the beginning of the war. The enlargement of known reserves is due largely to exploration work in the Cuyuna range district in Minnesota and in the Gogebic and other districts in Michigan. In the summer of 1916, when the season for open-pit mining and shipping of iron ore was at its height, strikes among mine and dock laborers threatened seriously to curtail output and shipments, but a firm hold on the situation by the mining companies, coupled with a disposition to share profits with employees, averted protracted trouble and made possible a record output of iron ore. In 1917 and 1918 also labor troubles threatened mining and shipment of ore in the Lake Superior district, but increased wages quieted much of the dissatisfaction, and the prospective alternative of having to return home and fight influenced many enemy alien miners to stick to their well-paid jobs. In 1916 the Lake transportation situation was aided by high water and generally favorable weather, and there was good team work between the Lake fleet and the railroads at both ends of the chain. In the last two years of the war transportation of iron ore was further systematized and coordinated with production and consumption, so that despite the loss of about 20 ore-carrying vessels commandeered for the Atlantic service relatively more ore was carried by the vessels available than formerly.

In other iron-ore districts, such as the Adirondack region, southeastern New York and northern New Jersey, and the Birmingham district, there was also much activity after the middle of 1915. These districts are relatively small, and their output could not have been increased in so large a proportion from existing mines, which are largely underground, had not the output of 1914 been much less than normal. In these and other small districts many long inactive mines were reopened; in fact, almost every mine that contained available ore of present commercial grade was drawn upon, and if an iron-ore mine could not be made to pay under war conditions there seems little hope for its immediate future.

Comparatively little iron ore is imported into the United States—normally between 1,500,000 and 2,500,000 tons a year, or about 2 to 4 per cent of the quantity annually consumed—but in the war years the imports were only between 780,000 tons and 1,350,000 tons. Moreover, the normal exports of iron ore partly offset the imports and in the last two years exceeded them, so that the United States is at present self-sufficient so far as the supply of iron ore is concerned. Such ore as has been imported in recent normal years has come mainly from Cuba, Newfoundland, Canada, Spain, Sweden, and Chile. Supplies from Newfoundland, Chile, and the United Kingdom, Germany, the Netherlands, and Belgium either diminished greatly or ceased altogether during the war. Supplies from Cuba, Canada, and Spain, however, continued to be imported.

Ore from Canada comes mainly from the Lake Superior district and is used at Michigan, Ohio, western Pennsylvania, and western New York furnaces, and it is also possible to import high-grade iron ores, such as are received from foreign countries for use in blast furnaces along the Atlantic seaboard, if there is no interference with shipping and when ocean freights are low and there is no tariff on the ore. Even under these favorable conditions, however, foreign ore rarely gets beyond the tidewater furnaces. During the later months of the war there was a threatened scarcity of low-phosphorus iron ore, which normally constitutes part of the ore imported from Canada, Spain, and Cuba. Residue from Spanish pyrites is also an important source of raw material for the manufacturer of low-phosphorus pig iron. In view of the impending shortage of low-phosphorus material efforts were made by the Government to have all low-phosphorus pyrite residues conserved and to encourage the development of domestic deposits of low-phosphorus ore. The magnetite of the East Mesabi district gives promise of affording important supplies of ore of desirable quality.

PIG IRON AND STEEL.

During the first year of the war there was so little demand for American iron and steel that not until June or July, 1915, did the price of pig iron begin to rise, and although at the end of the year prices were $1 to $1.25 a ton higher than at the beginning, the average price at blast furnaces of all grades of pig iron for 1915 was 21 cents lower than the average for 1914. By the beginning of 1916, however, the activity in the iron and steel industries had become extraordinary, and this activity was maintained with comparatively little variation throughout the year, as is indicated by the record of pig-iron production by months, which ranged between 3,000,000 tons and slightly over 3,500,000 tons. The total production in 1916 amounted to 39,434,797 gross tons, compared with 29,916,213 tons in 1915, an increase of 32 per cent, following a 28 per cent increase in 1915. In 1917 the output of pig iron was 38,621,216 tons, and in 1918 it was 39,054,644 tons, which was not quite equal to the record output of 1916. The yearly average production for the five years preceding the war was about 27,488,000 gross tons; for the five war years it was about 34,072,000 tons.

Prices of pig iron rose greatly during 1916. Southern foundry No. 2, at Birmingham, rose from $13 to $22 a ton, an increase of 69 per cent. Southern Ohio No. 2, at Ironton, seems to hold the record with an increase from $14 to $30, or 114 per cent, and the higher grades of iron also held up well, as indicated by the rise in Bessemer iron at Pittsburgh from $20 to $36, or 80 per cent. In the middle of July, 1917, the prices of basic pig iron at western Pennsylvania valley furnaces and of Bessemer pig iron at Pittsburgh reached $53 and $57.95 a ton, respectively,[1] the highest points since the Civil War. The regulation of prices by the Government brought them down rapidly, so that from October, 1917, until the end of 1918 they stood at $32 to $33 a ton.

At the outbreak of the war the iron and steel industry was operating on a subnormal scale, and consequently the manufacturing capacity was in excess of requirements. Some of this excess capacity was, of course, represented by antiquated equipment that could not be put into shape for resumption of operations on short notice. The excess capacity at the beginning of the war was greater in blast furnaces than in steel furnaces, so that one of the first effects of the war was to stimulate the building of new steel furnaces. According to the Iron Trade Review the steel-making capacity at the beginning of 1914 was estimated at 37,000,000 tons, at the beginning of 1915 at 37,500,000 tons; at the beginning of 1916 at 39,000,000 tons; on January 1, 1917, at 43,000,000 tons; on January 1, 1918, at about 48,000,000 tons; and at the end of 1918 at nearly 50,000,000 tons. Thus there was an increase in five years of 13,000,000 tons, or 35 per cent, in steel-making capacity. The pig-iron capacity is estimated to have been 35,000,000 tons at the beginning of 1914, about 39,000,000 tons at the beginning of 1915, more than 39,000,000 tons at the beginning of 1916, 40,000,000 tons at the beginning of 1917, 42,500,000 tons at the beginning of 1918, and about 44,000,000 tons at the end of 1918. The pig-iron capacity thus increased during the war about 9,000,000 tons, or more than 25 per cent.

The iron and steel-making capacity at the end of 1918 was none too large to fulfill war demands. The excessively high prices that were reached before the Government undertook to regulate prices stimulated expansion of manufacturing capacity to a great degree. There are of course limitations to expansion other than the demands for iron and steel. The capital involved in the iron and steel industry is so vast that ordinarily the future has to be taken seriously into consideration in planning new plants or additions to old plants. War-time demands and prices, however, upset many precedents and encouraged many increases in plant capacity irrespective of the consideration whether or not they might prove excessive after the war. This was particularly true of concerns whose profits were great enough to pay off back indebtedness and also to pay for the additions to their plants within a year or two of their construction. In looking to the future the optimist has seen a demand heavier than normal after the war. Several factors in the domestic situation have appeared encouraging, such as the needs of the railways, of building construction, of the automobile industry, and of shipbuilding. Railway and general building and improvement work, except where urgently needed, is usually postponed in times of high prices and uncertain deliveries, but the longer these industries are deprived of supplies through such conditions the greater the flood of orders that will be released when conditions once more approach normal. Foreign trade with South America and the Orient is expected to grow, and European trade in the necessities of peace is expected to be augmented. The entry of the United States into the war and the demands of this Government for iron and steel of course at once raised the question whether further increases in capacity were absolutely needed on that account. Government control of the industry and reduction of prices to a level very much below those current in the spring of 1917 deterred further great increases in capacities inasmuch as profits from Government orders were not sufficient to pay for such increases within a few months. There were also certain factors that vitally affected the manufacturing capacity at times. Among these were limitations of supplies of coke and other fuel and of ore, due to insufficiency of transportation facilities and of labor, as well as shortage of labor at the steel mills. One outstanding feature of war conditions is the great increase in shipyards, munition factories, and establishments for making the many articles used in warfare as well as tools and machinery for the industries expanded by war demands.

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[1] Iron Age, July 19, 1917, p. 149.

The great accomplishments of the iron and steel industry during the war were due to many interdependent factors, such as the coordination and cooperation of all interests concerned, the willing surrender to the Government of control over transportation, supplies, output, and prices, and the patriotic response of the industry as a whole to the call for increased production.

SECONDARY METALS.

By J. P. Dunlop.

INTRODUCTION.

SCOPE OF REPORT.

"Secondary metals" are those recovered from scrap metal, sweepings, skimmings, and drosses, and are so called to distinguish them from the metals derived directly from ores, which are termed "primary metals." The distinction does not imply that secondary metals are of inferior quality, for metals derived whether from ore or from waste material vary in purity and in adaptability for use in making certain products. The reports to the United States Geological Survey now include the secondary recoveries of copper, zinc, lead, tin, antimony, aluminum, and nickel. The figures obtained by the Survey are given as a supplement to the regular reports on primary metals in order to enable producers and consumers to form a more comprehensive idea of the quantities of metal available for consumption; in fact, they constitute an essential addition to the seven general reports on primary metals, though only a part of the recovery of waste metals is given.

RECOVERY OF WASTE MATERIAL.

NEED OF CONSERVING WASTE MATERIAL.

Since the armistice was signed there has been a decided decrease in the clamor urging the necessity of careful utilization of waste material. No longer do hordes of voluntary enthusiasts collect tin foil and waste paper for charitable reasons. Except for the Salvation Army and a few individuals with set purpose and unusual pertinacity the collection of waste materials has subsided into the regular channels. However praiseworthy such sporadic collecting was during the war, its continuance now that the war is over is not generally desirable, for it is more practical and more economical that the collection, buying, sorting, and selling of waste be done strictly on business principles, which are more conducive to a sustained, steady flow of material. Spasmodic effort in the collection of waste tends to discourage the primary collection of waste material by those who make a living by so doing. The comparatively small profits made by such persons and the high prices paid for unskilled labor have adversely affected the industry. Fewer individuals than usual are engaged in collecting waste from households and farms. The wastes from manufacturing plants are more adequately taken care of than ever, but the enthusiasm caused by the war which stimulated the saving of old material has subsided.

There is, however, as great a need as ever of saving and using waste, not sporadically but systematically and not to win the war but to lower the prices of many things made wholly or partly from waste products. The expense of gathering, sorting, and selling waste material has increased enormously, and there is an urgent necessity of reducing such costs. The price paid for labor probably will not soon decrease appreciably, so that the only method of reducing costs is to cut the quantity of labor required to handle waste material; and this can be done only by lessening the amount of sorting and handling by the primary buyers. The prices paid by the ultimate consumer of waste go mainly to pay for sorting, packing, and transportation, and these charges, which often exceed the amount paid for the waste itself are more likely to increase than to decrease. The only solution appears to be a more thorough segregation of household and shop waste by individuals in communities, so that the wastes can be collected and shipped directly to dealers, brokers, and users, with the minimum of handling. Unless old tin-coated food containers are collected more cheaply, it is probable that none can be profitably shipped to detinning plants in 1920. European nations have always made a closer recovery and use of metal and other wastes than we have, and they will undoubtedly increase their efficiency in that respect from the sheer necessity of saving part of the money normally spent for the purchase of imported metals. The war taught commercial interests that the prices of most metals and many other products were not dependent on domestic conditions, but were subject to world-wide influences. Cost of labor will be more and more nearly equaled in all countries, and competitive prices will be based on efficiency in manufacturing. This efficiency in large part depends on the use of the lowest-priced material suitable for the purpose and the minimum possible loss of material in manufacturing. Scrap or junk of necessity always costs less than new material, but its use requires more care and technical ability. It is certain that greater attention is to be given to the proper use of waste and that more money will be devoted to methods which will expand the use of waste and reduce the losses caused by carelessness and lack of technical supervision. Considerable attention is being given in Europe to the utilization of superfluous war material. Some interesting results of experiments in England are given in the Waste Trade Journal, September 6, 1919, as follows:

> Shells of various caliber have been proved by experimentation to have considerable commercial possibilities. The steel of which they are made is in many cases capable of being rendered glass-hard, and milling cutters have been produced which are reported to have stood the most exacting tests. After a little manipulation in the lathe, an 18-pounder shell, minus nose and copper band, makes an excellent shafting coupling, the copper bands selling at a good price for electrical and other purposes. A 6-inch shell in the same way becomes a fine flexible coupling, and so on. Shells being already hollowed out, there is a great saving in labor and material by using them instead of solid steel for couplings and other articles, when the dimensions are suitable. A special lathe extension constructed from spare parts enables waste 18-pounder cartridge cases to be cut into strip brass, and containers from shrapnel shells can be used, with a slight alteration, as lamps.

SOURCES OF INFORMATION.

The Geological Survey frequently receives letters inquiring as to the treatment of drosses and skimmings of alloys suitable for certain products and making other technical inquiries which it is not able to answer, though it endeavors to indicate where such information may be obtained. There are many trade papers and journals which give the source and nature of waste material and the prevailing prices of all kinds of scrap metals. They also contain replies to many questions relating to remelting, refining, and proper methods of alloying.

To keep in touch with the daily changes of the business world every manufacturer using metals and every buyer, seller, and broker of metals should receive some or all of the daily trade papers. Many of these papers, such as the American Metal Market, Daily Metal Reporter, and Daily Iron Trade and Metal Market Report, have special representatives at Washington and in other places who promptly report and comment upon all matters that affect metals and products made from metal. In addition to the trade papers issued daily, everyone interested in metals should obtain the more comprehensive and technical information given in weekly or monthly trade journals, such as the Waste Trade Journal, the Metal Industry, the Brass World, Foundry, the Iron Age, and the Iron Trade Review.

Copies of the separate chapter on secondary metals from Mineral Resources, 1917, which contains an article entitled "Warring on waste," by William Crawford Hirsch, and excerpts on the character and proper use of many scrap metals, are still available and can be obtained from the Director, United States Geological Survey, Washington, D. C. A very useful and comprehensive book by George H. Manlove and Charles Vickers, entitled "Scrap metals," has been published by the Penton Publishing Co., Cleveland. Ohio.

CLASSIFICATION FOR OLD METALS.

The classification for old metals drawn up by the metal division of the National Association of Waste Material Dealers, and changed from time to time as was found desirable has become the standard all over the United States, with both dealers and manufacturers. The latest classification, Circular E, is effective until July 1, 1920, when a new circular will be issued. Aside from drawing up metal classifications, the metal division, as well as all other divisions of the association, has a grievance committee, whose duty it is to adjust differences between members or to arrange for arbitration if it becomes necessary to have such disputes arbitrated. The metal division of the association has in recent years been able to remedy trade abuses, and, as a result of the constructive work accomplished, it has attracted to it practically all domestic metal dealers of importance.

Standard classification for old metals, effective from July 1, 1919, to July 1, 1920.

1. Delivery:
    - (*a*) Delivery of more or less on the specified quantity up to 2½ per cent is permissible.
    - (*b*) If the term "about" is used, it is understood that 5 per cent, more or less, of the quantity may be delivered.

1. Delivery—Continued.
   (*c*) Should the seller fail to make deliveries as specified in the contract, the purchaser has the option of canceling all of the uncompleted deliveries or holding the seller for whatever damages the purchaser may sustain through failure to deliver, and if unable to agree on the amount of damages, the arbitration committee of the National Association of Waste Material Dealers, appointed for this purpose, to determine the amount of such damages.
   (*d*) In the event that buyer should claim the goods delivered on a contract are not up to the proper standard, and the seller claims that they are a proper delivery, the dispute shall be referred to the arbitration committee of the National Association of Waste Material Dealers, to be appointed for that purpose.
   (*e*) A contract for a carload, unless otherwise agreed upon, shall mean the minimum quantity recognized by the official classification tariff of the district in which the seller is located.
   (*f*) A ton shall be understood to be 2,000 pounds, unless otherwise specified.
   (*g*) If, through embargo, a delivery can not be made at the time specified, the contract shall remain valid, and shall be completed immediately on the lifting of the embargo, and terms of said contract shall not be changed.
2. Heavy copper: This shall consist of copper not less than one-sixteenth inch thick, and may include trolley wire, heavy field wire, heavy armature wire, that is not tangled, and also new copper clippings and punchings, untinned and clean, and copper segments that are clean.
3. No. 1 copper wire: To consist of clean untinned copper wire not smaller than No. 16 B. & S. wire gauge to be free from burnt copper wire which is brittle and all foreign substances.
4. No. 2 copper wire: To consist of miscellaneous clean copper wire such as of necessity would be taken out of the heavy copper and the No. 1 copper wire, but to be free of hair wire and burnt wire which is brittle.
5. Light copper: Shall consist of the bottoms of kettles and boilers, bath-tub linings, hair wire, burnt copper wire which is brittle, roofing copper and similar copper, free from radiators, brass, lead and solder connections, readily removable iron, old electrotype shells and free of excessive paint, tar, and scale.
6. Composition or red brass: Shall consist of red scrap brass, valves, machinery bearings, and other parts of machinery, including miscellaneous castings made of copper, tin, zinc, and/or lead, no piece to measure more than 12 inches over any one part, to be free of aluminum and manganese, also free of railroad boxes, cocks, and faucets, gates, pot pieces, ingots, and burned brass.
7. Railroad bearing: Shall consist of railroad boxes or car-journal bearings, must be old standard used scrap, free of yellow boxes, plastic and similar bearings, also iron-backed boxes, and must be free of babbitt; also free of excessive grease and dirt.
8. Cocks and faucets: To be mixed red and yellow, free of gas cocks and beer faucets; shall be at least half red.
9. Heavy yellow brass: Shall consist of heavy castings, rolled brass, rod brass ends, brass screws, and tinned or nickel-plated brass tubing; to be free of iron and dirt, and must be in pieces not too large for crucibles; no piece to measure more than 12 inches over any one part. Must also be free of aluminum and manganese mixtures. Condenser tubes shall not be considered as heavy brass.
10. Light brass: Shall consist of light sheet brass, forks and spoons, miscellaneous brass that is too light for heavy, to be free of any visible iron, radiators, gun shells containing paper, ashes or iron, loaded lamp bases and clock works.
11. New brass clippings: Shall consist of the cuttings of new sheet brass, to be absolutely clean and free from any foreign substances.
12. Brass tubing: Shall consist of brass tubing, free of nickel plating, tinned, soldered, or tubes with cast-brass connections. To be sound, clean tubes, free of sediment, and condenser tubes.
13. No. 1 composition turnings: To be free of aluminum, manganese, plastic, and yellow brass turnings, not to contain over 2 per cent iron, to be free of grindings or foreign material, especially babbitt, and free from adul-

terations made to resemble metal. Turnings not according to this specification subject to sample.

14. **No. 1 yellow brass turnings: Shall consist of strictly rod turnings, free of** aluminum, manganese, composition, and tobin turnings. Not to contain over 3 per cent of iron, oil, or other moisture, to be free of grindings and babbitts. To avoid dispute, to be sold subject to sample.
15. **No. 1 pewter: Shall consist of tableware and soda-fountain boxes, but in** any case must test 84 per cent tin. Syphon tops to be treated for separately.
16. **Auto radiators: To be classed separately, must be free from iron.**
17. **Zinc:** Must consist of clean sheet and cast zinc, also cast batteries to be free of loose oxide and dross, salamoniac cans, and other foreign materials.
18. **Tin foil: Shall consist of pure foil free of lead compositions and other foreign ingredients and matters.**
19. **Electrotype shells: Must be hand picked and free of dross.**
20. **Battery lead plates:** Shall consist of battery lead plates, free of wood, rubber, and paper.
21. **New sheet aluminum clippings: Shall consist of new sheet aluminum and** cuttings. Must be free from oil, grease, and any other foreign substances. Must be guaranteed not less than 98 per cent pure aluminum.
22. **Aluminum wire: Shall consist of aluminum wire guaranteed 98 to 99 per** cent pure aluminum and must be free from corrosion and any other foreign substance.
23. **Painted sheet aluminum: Shall consist of painted sheet aluminum and must** be absolutely free from iron, dirt, or any other foreign substance.
24. **Aluminum castings: Shall consist of aluminum castings, free from iron,** babbitt, brass, and any other foreign substance. Must not exceed 2 per cent of oil and grease.
25. **Old sheet aluminum: Shall consist of old and manufactured sheet aluminum.** Must be free from painted sheet aluminum, iron, dirt, and any other foreign substance.
26. **Aluminum borings: To avoid dispute, should be sold subject to sample.**
27. **Aluminum foil: Shall consist of pure aluminum foil, free from paper, and** any foreign ingredients.
28. **Babbitt metal:** Shall contain bearing metal of all kinds. **Shall not contain** scrap hard metal, Allen metal (which is copper and lead alloy) die cast, zinc boxes, or type metal.
20. **Packages: Shall be good, strong packages, suitable for shipment, and each** package to be plainly marked with the gross and tare weights so that when packages reach their destination their weights can be easily checked. When goods are not packed according to the above specification and shipper wants his rejections returned, the cost of labor shall be charged to the shipper.

REVIEW OF THE SECONDARY METALS INDUSTRY IN 1918.

Dealers in and refiners and smelters of scrap metals and drosses continued to do a large business up to November, 1918, but the business done was not so profitable or so large as in 1916 and 1917. During the last two months of 1918, however, business was stagnant and the value of stocks decreased considerably. The stocks of scrap metal in the hands of dealers were not large, because there had been a very active demand for copper, aluminum, lead, and tin, and purchases of scrap containing zinc and antimony had been limited to avoid probable losses through declining prices. Profits were less because prices were fixed for many metals and expenses were much larger than in 1916. There was less old used material, because less old machinery, equipment, and buildings were scrapped, notwithstanding the active campaign to stimulate the collection of waste. The nonessential industries used a larger proportion of scrap metals than in 1917, but the plants that worked at high pressure to make products necessary for war uses yielded large quantities of scrap metals, and their consumption of new scrap was lessened by the necessity of speeding up deliveries by using pig metal. Thus there was a large accumulation of clean new scrap, especially scrap brass and scrap steel, at manufacturing plants at the end of 1918, which will be used in 1919.

Part of the metal or metals contained in drosses and skimmings undoubtedly is recovered and reused several times in one year. Similar conditions prevail in the use of all junk or waste material. New clean scrap is sold and becomes mixed with old scrap contained in articles that have been used and discarded. New clean clippings of zinc, tin, and aluminum are usually carefully segregated from other scrap metals, but many dealers in metals, or smelters, do not keep separate records of other new clean scrap and old used metals. The quantity of the various metals contained in numerous alloys made partly or wholly from secondary material can not be definitely ascertained. The figures given as the result of the inquiry made by the Geological Survey are only approximate, but they are the only available data of an important industry.

The value of the secondary metals, exclusive of gold, silver, platinum, iron, steel, and ferroalloys, recovered in the United States decreased from $295,854,900 in 1917 to $264,298,900 in 1918. The decrease was due to much lower average price of copper, zinc, lead, and antimony.

The value of the secondary platinum, iridium, and palladium recovered in 1918 amounted to $5,079,000, which was nearly as much as the value of the platinum and allied metals imported for consumption in the United States in 1918.

The value of the old jewelry, dental waste, silver spoons, tableware, ornaments, and other articles containing gold or silver remelted or refined in 1918 was more than $25,500,000. Mints and refineries reported the recovery of 8,526,122 fine ounces of silver and $16,931,600 of gold from waste or discarded material. Jewelry and dental waste are the largest sources of secondary gold, and silverware and photographic wastes of secondary silver. The increased value of silver naturally resulted in the return of large quantities of old spoons and other tableware to the melters, and the large increased sales of photographic material resulted in an increased quantity of silver used in that industry. Some idea of the recovery of silver from moving-picture laboratories is furnished by the fact that one small refining plant reported the recovery of more than 30,000 ounces of silver from photographic waste. It is difficult to estimate the value of ferrous scrap remelted in 1918. Estimates of the quantity vary from 12,000,000 to 14,000,000 long tons. Owing to the enormous consumption of iron and steel for war purposes there was a large increase in the quantity of scrap ferrous alloys available. A considerable part of the scrap ferrous metal contained nickel, tungsten, manganese, chromium, vanadium, molybdenum, or other alloys, which made it many times more valuable than the ordinary commercial iron and steel scrap, though the market is limited and some knowledge is necessary to locate prospective purchasers. All of this high-priced ferrous metal scrap will be absorbed into trade channels, though it will take considerable time to use the large accumulations of nickel steel and other special ferrous alloys. There continued to be a considerable quantity of scrap metals from abandoned steam and trolley railways, but the quantity of old metals marketed by operating railway companies was less than usual. Buying of new material by railways was restricted to urgent needs, consequently smaller quantities of old rails, car wheels, and other equipment were discarded. The railways are on the whole the largest producers of most kinds of metal scrap, as well as the largest users of new and remelted metal. It is estimated that the railways discard more than 8,000,000 tons of iron and steel yearly. One large railway company estimated that its purchases and manufacture of bearing metals in 1917 amounted to more than 21,000,000 pounds.

The dealers and brokers in ferrous metals think that the prices paid by users of iron and steel scrap since November, 1918, have not been fair in that they have showed a much greater percentage of decrease than the prices of iron and steel products made from this old material.

It is impracticable and unnecessary to segregate the statistics relating to the melting, refining, and using of secondary metals according to States, but more than 90 per cent of the refining and smelting of drosses and scrap metals in the United States is confined to the territory east of St. Louis and north of Ohio River.

Nearly all the secondary aluminum was reported from the States of Ohio, Michigan, Connecticut, Illinois, Indiana, and Wisconsin.

The largest recoveries from tin dross, tin scruff, and clean tin scrap were made in Pennsylvania, New York, and New Jersey. Nearly all the secondary nickel was reported from Connecticut. The recoveries of lead, zinc, and copper and of such alloys as babbitt, bronze, brass, and pewter were more generally distributed, though the largest secondary smelters and refiners are located in Pennsylvania, Illinois, Michigan, and New York.

William Crawford Hirsch, editor of the Waste Trade Journal and an authority on the secondary-metals markets, reviews the situation ably as follows:

> As the war brought out in the individual citizen virtues until then latent, so many of the Nation's industries, when the Battle Hymn of the Republic was sounded, unfolded a usefulness heretofore but little dreamed of. No more impressive instance of this sort is on record than that of the secondary-metals industry. It is not so much the extent to which scrap metals were used in the manufacture of war material that challenges attention as the potentially important reserve of raw materials made possible by their intensified collection and utilization, which undoubtedly would have been one of the deciding factors had the war continued longer. It is true that sufficient copper, lead, and zinc was mined and refined to supply the needs of our Army and Navy as well as those of some of the nations associated with us in the war, but the adequacy of the virgin supply must be ascribed in large measure to the extent to which scrap metals were used in place of virgin in the Nation's industries, many of which contributed material essential to the conduct of the war. Yet even amid the tremendously quickened production of our mines and refineries, signs were not wanting shortly before the signing of the armistice that in at least one of the important war metals—that is, lead—paucity in supply was beginning to appear. It may therefore be said that secondary metals constituted a sort of second line of defense which would have given us superiority in resources over those of the enemy had he continued to offer resistance.
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> As for tin, one of the few metals for the supply of which we were dependent upon foreign sources, secondary metal actually did bridge on several occasions the chasm between famine and fresh arrivals. The naval authorities, at all times during the war solicitous that the supply of Straits tin be conserved against actual war needs, had to resort once or twice to the extreme of commandeering arrivals of this grade of tin. The scarcity of all kinds of tin,

albeit it may have been in part artificial, resulted in values crossing the $1 a pound line, and for a time block-tin scrap commanded prices very close to that level. Under the guidance of the War Industries Board, the manufacturers of babbitt and kindred lining alloys reduced to a considerable extent the quantities of tin they consumed by lessening the percentage of that metal in their alloys. Although no statistics are available on the subject, it is safe to assume that the bulk of their requirements were met from the supply of secondary tin.

The attitude taken by the War Industries Board toward secondary metals is of interest. The secondary metals committee sought on several occasions a ruling regarding maximum prices on certain grades of scrap, but Mr. Pope Yeatman, chief of the nonferrous metal division of the War Industries Board, adhered steadfastly and consistently to the ruling that scrap copper was copper and scrap aluminum aluminum, wherefore the maximum prices on the virgin metals were binding also on their secondary offspring. In the case of alloy scrap, such as brass, it was assumed that the maximum prices governing their constituents applied to the extent of the percentage contained in the composition. A brass containing 70 per cent copper could not be sold at a higher price than 70 per cent of the maximum price on copper plus the market price for the zinc. The lead producers' committee, which had no official standing, imposed the maximum price for virgin lead as the maximum price on scrap, relying upon the cooperation of the trade to enforce its decree.

For the greater part of 1918 copper scrap ruled well below the price of the virgin metal, largely because of the abundance of the supply emanating from the munitions industries. Although the maximum price for virgin metal was 23.50 cents a pound, crucible copper scrap fluctuated between 21.87½ and 22.50 cents. When the 26-cent maximum price was promulgated in July, prices for scrap began to climb until they reached 24.25 cents. With the signing of the armistice prices tumbled, and the year's end found the crucible price at 18.50 cents—25 per cent below the year's high level.

Red brass scrap, or "No. 1 composition," as it is called in the trade, benefitted from the flurry in the tin market, because of its high content of that metal, selling at times at as high a price as crucible copper. At the end of the year its price had fallen to 17 cents. The heavy production of yellow brass scrap by ordnance manufacturers caused the market for that alloy to be exceedingly weak throughout the year, a condition which prevailed long after the signing of the armistice and which was still further aggravated by the large surplus holdings of brass which the Government had on its hands when hostilities ended and which had to be disposed of to a large extent in competition with the scrap-brass holdings of dealers.

Lead scrap was firm throughout the period under consideration, and frequently premiums were paid, especially during the time when virgin lead was unobtainable by anyone who did not hold a Government contract. Aluminum scrap was also in buoyant demand throughout the year. The sole producer of virgin aluminum had his entire capacity taken up with Government contracts, and what secondary metal was available was eagerly bought by consumers unable to secure virgin metal.

As for ferrous scrap, the market was under close control throughout the year, maximum prices governing in all transactions and distributions being supervised by a committee of the American Iron and Steel Institute. Toward the close of hostilities large quantities of shell-steel scrap began to come on the market and the need of maximum prices vanished. Disposal of the Government's iron and steel scrap holdings has extended into the year 1919, and it will be several years before the last of this war surplus has been melted. Sight must not be lost, however, of the fact that in scrap iron as well as in the nonferrous scrap metal collections from industrial and other ordinary sources fell to negligible proportions during the war, and that the Government's surplus holdings came on the market at a time when otherwise it might have found itself critically short of supplies.

As to the future of the secondary metal industry, it would seem that one of the crying needs of the hour is the stabilizing of values through the adoption of a more rational basis of trading than that now in vogue. It happens frequently that certain grades of scrap sell at prices entirely out of proportion to the price levels of the corresponding virgin metals. All secondary metals have a certain melting value dependent upon whatever price prevails for their virgin progenitor. The scrap grade known as crucible copper is in every respect as rich in pure copper as electrolytic virgin metal, and the only rational method of determining its value is by allowing a certain percentage for loss of weight in melting and for the cost of that operation as compared with the melting of virgin copper. In other words, the sane market quotations for crucible copper scrap would be one expressed in percentage of the market price of electrolytic. Heavy copper used in the manufacture of castings would be worth such a percentage of the quotation for casting copper.

It would be a relatively easy matter to agree upon the loss incurred in the melting of every kind of scrap and this loss expressed in percentage would then be deducted from the market value of the corresponding virgin metal. In alloys, such as brass, this plan might offer some difficulties, but even there the difficulty can be surmounted. In the case of copper, lead, and aluminum (clippings) scrap the present system of a market separate from that for the virgin metals is, to say the least, unscientific. Heavy melting steel scrap sells at times at 25 per cent below the price of basic pig iron when, in fact, its melting value is on a parity with that of virgin iron. Reform along these lines would go far toward eliminating the kind of speculation that hurts rather than aids a commodity. Cotton waste is sold on a basis of percentages either added to or deducted from the market price of upland middling new cotton. A similar system of percentages can be introduced to great advantage in the markets, both for scrap nonferrous metals and for scrap iron. The War Industries Board held correctly that scrap copper is copper and scrap aluminum is aluminum. Why then should they not be sold on the basis of virgin copper and virgin aluminum?

SECONDARY METALS RECOVERED.

Secondary metals recovered in the United States in 1917 and 1918.

	1917		1918	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Secondary copper, including that in alloys other than brass	159,400	$87,032,400	122,510	$60,519,900
Remelted brass	320,000	141,888,000	328,800	128,696,300
Secondary lead	45,100	16,082,000	41,146	13,788,200
Recovered lead in alloys	48,400		55,954	
Secondary zinc	31,400	7,384,800	27,108	6,950,600
Recovered zinc in alloys other than brass	4,800		11,082	
Secondary tin	6,000	23,920,200	7,142	41,381,000
Recovered tin in alloys	13,400		16,695	
Secondary antimony	6	2,061,700	43	1,317,000
Recovered antimony in alloys	4,955		5,183	
Secondary aluminum	6,660	16,711,800	6,050	10,113,600
Recovered aluminum in alloys	9,440		9,000	
Secondary nickel [a]	60	774,000	178	1,532,300
Recovered nickel in alloys [a]	800		1,215	
	....	295,854,000	....	264,298,900

[a] Recoveries made by International Nickel Co. from scrap nickel or alloys and from nickel in scrap ferrous alloys from any source are not included.

SECONDARY COPPER.

The total quantity of secondary copper recovered in 1918, on the assumption that the brass remelted had an average copper content of 70 per cent, was 352,670 short tons, of which 21,846 tons (17,712 tons less than in 1917) was recovered by plants refining primary metals and the remainder by plants treating only secondary materials. The copper produced by smelters of the latter class includes 66,284 tons of pig copper, 34,380 tons of copper in alloys other than brass, and 230,160 tons of copper in remelted brass. These figures indicate a decrease for 1918 of about 22,150 tons of pig copper, and an increase of 6,160 tons of copper in brass and of about 3,040 tons in alloys other than brass. At least 176,000 tons was recovered from clean scrap made in the course of manufacture of copper and brass ware, so that less than 177,000 tons was obtained from ashes, cinders, and scrap, or from material that had actually been used and discarded. From the reports received it is quite evident that there was a decrease in the quantity of old copper smelted and that there was not so large a decrease in the quantity of clean new copper and brass scrap remelted. The reports from munition factories show an enormous increase in the quantity of clean scrap remelted, and there was a decrease in the quantity of scrap brass from other users. The quantity of scrap brass used amounted to 328,800 tons, and of this at least 200,000 tons was clean new punchings, filings, and clippings.

It is stated by P. E. McKinney, chemist and metallurgist of the Naval Gun Factory, United States Navy Yard, Washington, D. C., that results obtained from three years operation have shown conclusively that the alloy known as manganese bronze may be made without resorting to the use of high-grade virgin metals. The alloy was produced in a reverberatory furnace from materials which are of low grade, such as yellow brass machine-shop turnings, zinc dross from galvanizing pots, aluminum turnings, old zinc scrap, foundry floor scrap and skimmings, and scrap copper. A description of the material and methods used and the result of tests of the ingots made is given in the Brass World for March, 1919.

The value of the copper, both as metal and in alloys, is computed at the average yearly price of 24.7 cents a pound, the average sales price of all marketable grades of new metal.

According to the Bureau of Foreign and Domestic Commerce the exports for the calendar year 1918 of scrap brass and copper, fit only for remanufacture, were 2,455 tons of scrap brass and 129 tons of scrap copper, and the imports of scrap copper were 959 and of scrap brass 6,114 tons. Many railways sell or turn in the larger portion of their brass and copper scrap and other metal waste to dealers in part payment for new material; but the reports received show that the railways utilized in their own shops and foundries more than 12,230 tons of brass, in addition to 1,031 tons of copper and 3,573 tons of copper in alloys other than brass. The railway reports, however, frequently include alloys termed brass which should more properly be designated bronze. There was a decrease of about 20 per cent in the quantity of copper and copper alloys used by railways in 1918.

The production of copper from secondary sources in 1918 was equal to about 29 per cent of the refinery output of primary copper in the United States from all sources, or about 37 per cent of the primary copper smelted from domestic ore.

Secondary copper, 1918.

	Short tons.
Copper from scrap, drosses, ashes	88,130
Copper in alloys other than brass	34,380
	122,510
From new scrap	36,000
From old scrap	86,510
	122,510

	Short tons.
Brass scrap melted:	
New clean scrap	200,000
Old scrap	128,800
	328,800
Copper content of brass scrap (averaging about 70 per cent copper):	
New scrap	140,000
Old scrap	90,160
	230,160
Total copper produced from secondary sources:	
From new scrap	176,000
From old scrap	176,670
	352,670
Exports of scrap brass in 1918	2,455
Exports of scrap copper in 1918	129
Imports of scrap brass in 1918	6,114
Imports of scrap copper in 1918	959

SECONDARY LEAD.

The secondary lead recovered in 1918 amounted to 97,100 short tons, or about 3,600 tons more than in 1918. The secondary lead recovered as pig lead decreased about 4,000 tons, and the recovery of secondary pig lead made by those smelters whose product is mainly primary metal was about the same in 1918 as it was in 1917. The quantity of secondary lead recovered in alloys increased from 48,400 tons in 1917 to 55,954 tons in 1918, so that the increase in secondary lead was entirely due to the larger quantity of alloys containing lead treated by smelters which treat scrap and drosses only. A portion of the recovered lead in alloys was derived from old babbitt, solder, type metal, and white metal drosses. The main sources of secondary pig lead are old pipe, lead cable, battery lead, and lead lining of acid tanks. Regular smelters reported the recovery of 2,328 tons of lead in scrap antimonial lead. It is stated that the manufacturers of toys formerly imported from Europe consume a large quantity of impure and very low-grade lead scrap.

The quantity of scrap antimonial lead remelted by regular smelters was nearly 47 per cent less than that reported in 1917.

The total output of secondary lead was equal to about 15.2 per cent of the refined primary lead produced in the United States in 1918, compared with 15.3 per cent in 1917. It was exceeded by the primary domestic lead output of only two States—Missouri and Idaho.

Secondary lead, 1918.

	Short tons.
Secondary lead recovered by smelters that treat mainly ores	7,276
Secondary lead from plants treating only scrap and drosses	33,870
	41,146
Secondary lead contained in remelted alloys:	
Lead content of antimonial lead scrap treated at regular lead smelters	2,328
Lead in drosses and scrap alloys recovered at secondary smelters	53,626
Total in alloys	55,954
Total recovery of secondary lead	97,100

SECONDARY ZINC.

The output of secondary zinc (including that in brass) amounted to 120,590 tons and equaled 23 per cent of the production of primary zinc in the United States in 1918, compared with 17 per cent in 1917. The recovery was about 4,400 tons more than in 1917, and all the increase was due to the increased quantity of zinc contained in brass and other alloys recovered, for the recovery from scrap zinc dross and skimmings was about 4,300 tons less in 1918 than in 1917.

Two smelters in New Jersey, two in New York, and one in California, which treat only zinc drosses and skimmings, use large graphite retorts of 600 to 800 pounds' capacity instead of the small clay retorts used by smelters treating ore or mixed ore and drosses. The many uses of zinc drosses and skimmings create active competition for their purchase. Considerable zinc is recovered by sweating, and the residues are sold for redistillation. Secondary zinc varies in quality just as the zinc derived from ore does, but a part of the secondary zinc is reported to be of excellent quality.

The production of zinc from drosses and skimmings made by those zinc smelters that also treat ores was about 600 tons less in 1918 than in 1917. The zinc smelters that treat drosses only obtained 1,987 tons of zinc by redistillation in 1918, as compared with 8,316 tons in 1917. These decreases were due in part to the redistillation of the low grades of zinc in order to meet the demand for zinc suitable for brass used in making war munitions, and also in part to the larger quantity of zinc residues used for other purposes. The main reason, however, was that the quantity of galvanized sheets, pipes, and forms produced in 1918 was 640,444 short tons, against 987,527 tons in 1913, so that less zinc dross was shipped by galvanizing plants and a large quantity of drosses, skimmings, and ashes was exported.

The zinc recovered in alloys other than brass amounted to 11,082 tons, compared with 4,800 tons in 1917. Of the 27,108 tons of secondary zinc recovered unalloyed, 9,918 tons was obtained by redistillation from drosses and skimmings. Of this quantity 7,931 tons was obtained by smelters whose principal source of zinc is ore. This was about 600 tons less than the recovery from drosses and skimmings in 1917. The quantity of zinc recovered by sweating and remelting increased from 14,565 tons in 1917 to 17,190 tons in 1918. In addition to the 27,108 tons of remelted and redistilled zinc it is estimated that at least 24,000 tons of zinc chloride was made, and likewise about 62,403 tons (marketed production) of the zinc pigment lithopone (containing approximately 22 per cent zinc sulphide and oxide). The zinc used in both of the last-named products is derived largely from zinc drosses and skimmings, of which 25,500 short tons was used in addition to some zinc oxide. The exports of zinc drosses, which amounted to 2,536 tons in 1914, to 4,167 tons in 1915, to 48 tons in 1916, increased to 13,302 tons in 1917 and to 15,816 tons in 1918. The zinc obtained by redistillation decreased from 16,835 tons in 1917 to 9,918 tons in 1918, and the zinc recovered in brass increased from about 80,000 tons in 1917 to about 82,400 tons in 1918.

The urgent demand for scrap steel has resulted in establishing a new industry—that of degalvanizing old zinc-coated scrap so that the steel can be utilized. The zinc coating is removed by the niter cake process and marketed as zinc carbonate or zinc sulphate. It is stated that some of the plants have had difficulty in profitably marketing the zinc compounds produced from the scrap. A large part of the secondary zinc which is not recovered by redistillation is obtained from what is termed zinc dross or galvanizer's dross, which is merely an alloy of iron and zinc that sinks to the bottom of the kettle and is removed from time to time. It is an alloy of zinc with more than 3 per cent of iron which makes the zinc thick. This thick zinc is refined by melting it in a kettle, getting it sufficiently hot to be fluid, and then introducing by means of a phosphorizer a crucible material, a small quantity of a mixture of chopped potatoes, sulphur, and leather. The dross rises to the top and is skimmed off, and the iron forms a sulphide matte which sinks to the bottom of the kettle. The operation is repeated several times, and the result is that the zinc is purified of the iron. As the zinc is now oxidized it is deoxidized by the introduction of aluminum, about 1.001 per cent being sufficient. This method produces an excellent grade of zinc that will run under 0.25 per cent of iron and will be over 98 per cent pure.

Secondary zinc, 1918.

	Short tons.
Zinc recovered by redistillation by regular smelting plants that also treat ores	7,931
Zinc recovered by redistillation at plants that treat only secondary material	1,987
Total redistilled	9,918
Zinc recovered by remelting, sweating, etc	17,190
Total zinc recovered unalloyed	27,108
Zinc recovered in alloys other than brass	11,082
Zinc recovered in brass (estimated)	82,400
	120,590

SECONDARY ANTIMONY.

The production of secondary antimony, of which all but 43 tons was recovered in alloys, increased from 4,961 short tons in 1917 to 5,226 short tons in 1918. The value assigned is arbitrary and is based on the average yearly price for ordinary brands of antimony published by the American Metal Market. The regular smelters reported the recovery of 375 tons of antimony contained in 2,703 tons of antimonial lead scrap. The principal materials refined or remelted which contained antimony as an alloy were hard-lead drosses, babbitt, solder, pewter, and type metal. Antimony used in the rubber, glass, enamel, paint, and ceramic industries and also for war uses does not yield any secondary recoveries. The use of antimony for shrapnel bullets, for primers, for coloring rubber, and for pigments has materially increased in the last three years. The imports in 1918 of antimony as metal in ore or as oxide or salts amounted to 16,287 short tons, and the recovery from secondary sources was equal to 32 per cent of the imports. The production of antimony from domestic antimony ore was 127 tons and the antimony content of antimonial lead of domestic origin in 1918 was 1,557 tons—a total of 1,684 tons, or equal to about 32 per cent of the quantity recovered from secondary sources.

SECONDARY TIN

Although the United States consumes more than 50 per cent of the world's production of tin, apparently there were only 105 tons of domestic tin ores containing 69 tons of metallic tin smelted in the United States in 1918. Nearly all of this ore was produced in Alaska, and the rest in South Dakota and the Carolina tin belt. The American Smelting & Refining Co. imported and smelted tin concentrates from Bolivia at its plant in New Jersey. Tin concentrates from Bolivia were also smelted in electric furnaces by the Andes Electin Co., of New York, and some tin was also smelted by the Eastern Metal & Refining Co., of Boston, Mass. The new plant of the Williams Harvey Corporation, on Jamaica Bay, Brooklyn, N. Y., was first operated in November, 1918. These four smelters made an output of 10,284 short tons of tin in 1918.

The secondary tin recovered in 1918 was equal to about 29 per cent of the tin imported, as metal or as oxide, into the United States during the year (82,854 short tons). Secondary tin recoveries increased from 19,400 tons, valued at $23,920,200, in 1917 to 23,837 tons, valued at $41,381,000, in 1918. The quantity recovered as tin was 7,142 tons and that in alloys and chemical compounds 16,695 tons. The value of the recovered tin here assigned is arbitrary and is based on the yearly average price for new metal, 86.8 cents, given by the American Metal Market. The secondary tin in alloys increased about 3,300 tons and the secondary pig tin about 1,140 tons.

Nearly all clean tin-plate scrap is detinned by one of three processes—the electrolytic alkali, the chlorine, or the alkali saltpeter.[1]

By the first method the tin is recovered in the form of a spongy granulated precipitate, which can be remelted into pig tin; by the second process tetrachloride of tin is recovered for use in silk dyeing and weighting; and by the third process the tin is recovered as an oxide, which is either used as coloring in the enamel industry or is melted into pig tin by means of a reverberatory furnace.

A patent[2] (U. S. patent 1310381, dated July 15, 1919) has been granted to Daniel A. and Sidney H. Wilcox, of Garden City, N. Y. for a method of separating iron and tin and is based upon the fractional distillation of their chlorides. The scrap to be treated is compressed and heated to a temperature bringing a vigorous reaction when chlorine is passed over the metal, both metals being volatilized as chlorides. The scrap may be melted and the chlorine passed through or over the melted metal contained in a Bessemer converter, reverberatory, cupola, or blast furnace, electric melting furnace, or muffle furnace. By either method the mixed chlorides are separated by fractional condensation and the tin chloride may be converted into metallic tin or tin oxide. The ferric chloride is dissolved in water, reduced to ferrous chloride by passing the solution over hot iron, and electrolyzed, insoluble electrodes being used, so that the products are pure iron (some occluded hydrogen is present, but this may be removed by heat) and chlorine gas, which may again be utilized.

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[1] A short history of the detinning industry: Met. and Chem. Eng., August, 1917, pp. 187-189.

[2] Daily Metal Reporter, Sept. 13, 1919.

The recovered tin in alloys included the tin content of products made in several plants from clean tin-plate scrap and more than 15,000 long tons of old tin-coated cans. This included some tin oxide and putty powder but consisted mainly of tin chloride. The production of these compounds is calculated as metal and not separately stated, in order to avoid disclosing confidential information. As the products are made from scrap tin and thus conserve the primary metal, they are properly regarded as recovered tin.

The largest recoveries of tin were made from the scruff and drosses that occur in making tin plate and terneplate, and amounted to more than 5,300 tons. The quality of tin plate and terneplate made in 1918 was about the same as in 1917.

About 3,062 tons of tin were recovered from clean scrap tin plate either as pig tin or as tin chloride or tin oxide. Apparently only about 730 tons of pig tin were recovered from scrap tin (not tin plate) clippings, old tin pipe, tin foil, and collapsible tubes, and it is impossible to give the separate quantities of tin recovered from these sources. Old block-tin pipe is most acceptable scrap, but the quantity available is steadily declining.

More than 7,000 tons of the 7,492 short tons of tin-plate scrap imported in 1918 was from Canada. There was only a very small quantity of old tin-coated containers, used at plants, from which the tin coating and solder were first sweated and the black plate was then remelted to make sash weights. Some years clean new tin-plate scrap had been utilized by such plants, but the prices of such waste increased so much that it could not be used. The last two years the cost of collection and the high prices of fuel and labor precluded the use of old cans by sash-weight makers, except for an insignificant quantity obtained directly from the users of the contents packed in tin-coated containers.

Tin coated scrap and old cans are frequently utilized in western mining regions for their iron content in the precipitation of copper from mine waters; the tin coating, however, is wasted.

A large quantity of tin was recovered in bronze, and part of the brass remelted contains a small quantity of tin and of lead, which in the aggregate amounts to a considerable quantity, though in 1918 every effort was made to substitute other metals or to use a smaller percentage of tin in such alloys. Other alloys from which secondary tin was recovered were solder, babbitt, pewter, terne metal, and electrotype metal.

From reports received by the Geological Survey approximately 166,838 long tons of clean tin-plate scrap was detinned in 1918. This scrap and 15,090 long tons of old cans yielded 9,771,132 pounds of tin oxide, tin bichloride, and tin tetrachloride containing 4,365,810 pounds of tin, also 2,220,288 pounds of tin as metal. About 15,000 long tons of old tin-coated containers were used, from which tin chloride containing 459,500 pounds of tin was recovered. The average metallic content of the tin oxide was given as 78.9 per cent, that of the tin bichloride as 23.5 per cent, and that of the tin tetrachloride as 45.4 and 46 per cent.

The average recovery, in terms of metallic tin, per ton of clean tin-plate scrap treated in 1918 was 36.27 pounds, and the average recovery from old tin-coated cans was 30.56 pounds. The relatively small quantity of secondary tin recovered from tin plate scrap and old tin-coated cans is significantly shown when compared with the quantity of tin used in making tin plate. It is estimated that 28,000 tons of tin were used by makers of tin plate in 1918, and that the total recovery of tin as metal and in compounds from tin-plate scrap and old cans was 3,293 short tons, and that of this quantity only 228 tons was from old used cans. This shows that considerably less than 1 per cent of the tin used on old cans was recovered.

A small quantity of old cans was used by makers of window-sash weights, but more than 99 per cent of all the old cans utilized in 1918 were treated by the dry chlorine process at plants in New Jersey and at East Chicago, Ind., owned by the Metal & Thermit Co. and by the electrolytic process at the Sewaren, N. J., plant of the Vulcan Detinning Co. Most of the cans were received from Washington, Philadelphia, New York, Newark, Pittsburgh, Buffalo, Chicago, and Rochester, mainly from contractors gathering garbage and waste which was handled by means of picking belts. The cans purchased were classified as follows:

Class 1. Unused empty and unrusted tin cans not exceeding the 1-gallon size, with or without labels attached, but otherwise free from foreign material such as ice, water, ashes, paint, varnish, white lead, and similar insoluble (in water) contents.

Class 2. Used cans not exceeding the 1-gallon size and otherwise as described in class 1.

Class 3. Used empty and unrusted tin cans exceeding in size the 1-gallon size but not exceeding the 5-gallon size and otherwise as described in class 1.

Each class should be packed separately and shipped in quantities weighing not less than 5,000 pounds net. In order to facilitate handling and save space it is advisable to crush or bale the cans. Care must be taken that the cans are not flattened entirely. A spacing of one-half to three-quarters of an inch should be left between the sides of the cans so that they can be cleaned and treated. During the first half of 1918 the quoted prices for old tin cans were $11 to $12 a long ton (2,240 pounds) delivered at Sewaren, N. J., Chrome, N. J., or East Chicago, Ind.

The largest user of old cans and scrap tin plate was the Metal & Thermit Co. The efficient plant of this company at Chrome, N. J., consists of separate units for scrap tin plate and for cans. The old cans are dumped directly from the cars into pits, where they are hoisted on conveyers, washed in alkali solutions to remove all paper, paint, and dirt, then compressed into oblong billets and placed in steel baskets. The baskets are placed in drums and the tin removed by means of chlorine. The capacity of the plant is increased by treating the cans under pressure, and the recovery of tin is more efficient. Very dirty lacquered or painted cans require a stronger solution to remove the coatings, and occasionally some of the tin is lost in cleaning them. The bundled scrap, after it is detinned, is dried and loaded on cars. This steel scrap can be used by steel plants, as it is practically free from tin. It is compressed into blocks, and in that form the smelting losses are reduced.

New tin-plate clippings were also treated at the above-named plants which treated old cans and also by the Johnson & Jennings Co., Cleveland, Ohio, and the Republic Chemical Co., of Pittsburgh, Pa. The five companies named are the only ones in the

United States which reported the detinning of tin-plate scrap or used tin-coated containers, and none of the municipalities which had considered installing plants to utilize metal wastes made any progress, so that it has not been determined whether a detinning plant can be profitably operated by a large municipality, using the combustible part of the city's refuse for power to operate the plant. It is almost certain that a municipality could not profitably treat old cans by the chlorine process, and even if cheap fuel was used to treat the old cans by melting the tin coating, the tin recovered would be small in quantity and of very low grade.

The plants now completed and utilizing old tin cans have never received shipments large enough to operate steadily at capacity even when the prices of tin and black sheet steel scrap were 50 per cent higher than those prevailing in 1919. The increased cost and scarcity of unskilled labor and the higher cost of cartage and freight have made it unprofitable for collectors of waste material to segregate and ship old cans, so that many contracts with detinning companies were not renewed in 1919. The detinning companies must reduce the price paid for old cans because their expenses of operating have increased and tin has declined to about 55 cents a pound in September, 1918, and bundled black plate scrap brings less than $9 a long ton. The supply of tin chloride, which is the main product of detinning plants, is ample since war uses have ceased—in fact, a considerable quantity of tin tetrachloride has been reclaimed from hand grenades. The tetrachloride was used in grenades to cause a dense white fume when the grenades were thrown and broken.

The detinning plants treating old cans can handle more than 25,000 tons of cans a year, but it is very doubtful if the consumption in 1919 will be more than 40 per cent of that capacity. The supply of used cans has been steadily decreasing as contracts expire, and this will necessitate the closing of several plants, for the margin of profit is small, and steady operation is required to make any profit. Old tin cans do not sell for more than $9 to $11 a long ton delivered at detinning plants, and thus they bring the shipper only $4 to $5 a long ton after loading and freight charges are paid. Contractors for refuse find it impossible to make any profit after paying the advanced costs of labor to sort and ship the tin cans. The only feasible method of obtaining a steady supply of cans is by a reduction in the cost of handling. This can be effected by municipal laws requiring clean rustless cans to be segregated by the householder and dumped by the collector directly into cars or into a baling machine. Unless the cost of common labor decreases materially or the methods of collecting the cans are changed, there will be a large decrease in the quantity of tin and steel recovered from used containers. Conditions are most unfavorable for the collection and utilization of used tin cans, and their bright glow and gaudy labels will continue to make more conspicuous the dumps of garbage and scrap that disfigure the outskirts of cities and towns. The collection of tin-foil and old collapsible tubes largely by persons and organizations for charitable purposes has also become less effective, because much of the foil and many other containers are not now made from tin or contain only a small quantity of tin. Small quantities of foil made from lead, zinc, or aluminum are not of much value and do not pay for the trouble of saving and selling. Considerable quantities of block-tin pipe were used in saloons, and the abolition of the liquor business renders available considerable tin from the scrapping of bar fixtures. Probably not more than 1,000 tons of tin was derived in 1918 from all the old tin pipe, collapsible tubes, and tin-foil marketed.

Although there is now a supply of tin sufficient for all requirements, there are two good reasons for restricting its use to the lowest point. One is that the supply of new tin is derived almost entirely from foreign sources, and the other is that tin is a relatively high-priced metal and the use of substitutes giving approximately equal efficiency radically reduces the cost of many alloys, such as solder, babbitt, and other bearing metals. A number of interesting and valuable papers[1] on the conservation of tin were read and discussed in October, 1918, at the meeting of the American Institute of Mining Engineers held at Milwaukee, Wis. The articles include the following:

Bronze-bearing metals, by G. H. Clamer.
Pennsylvania Railroad antifriction and bell metals, by F. M. Waring.
The tin-plate industry, by D. M. Buck.
The aluminum bronze industry, by W. M. Corse.
Bronzes, bearing metals, and solders, by G. K. Burgess and B. W. Woodward.
Babbitts and solders, by G. W. Thompson.
The cadmium supply of the United States, by C. E. Siebenthal.
Solder, its use and abuse, by M. L. Lissberger.

Secondary tin, 1918.

Tin recovered as pig tin____short tons__	7,142
Tin recovered in alloys and chemical compounds_do____	16,695
	23,837
Quantity of clean tin plate scrap treated, including 6,689 long tons imported in 1918____long tons__	166,838
Quantity of old tin coated containers treated____do__	15,090
Quantity of metallic tin recovered at detinning plants pounds__	2,220,288
Tin content of tin tetrachloride, tin bichloride, and tin oxide made at detinning plants____pounds__	4,365,810
	6,586,098
Quantity of tin oxide, tin bichloride, and tin tetrachloride, made at detinning plants____	9,771,132
Average recovery of tin per ton from old tin-coated containers____	30.56
Average recovery of tin per ton from clean tin plate scrap____	36.27

SECONDARY ALUMINUM.

The recovery of secondary aluminum as pig aluminum or in alloys in 1918 amounted to 15,050 tons, valued at $10,113,600, as compared with 16,100 tons, valued at $16,711,800, in 1917. The quantity recovered in alloys amounted to 9,000 tons.

Some of the larger secondary smelters and refiners of aluminum in 1918 were the Peninsular Smelting Co., Detroit, Mich.; United Smelting & Aluminum Co., New Haven, Conn.; United States Reduction Co., East Chicago, Ind.; Great Western Smelting & Refining Co., Chicago, Ill.; Cleveland Electro Metals Co., Cleveland,

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[1] Am. Inst. Min. Eng. Trans., December, 1918.

Ohio.; W. F. Jobbins Co. (Inc.), Aurora, Ill.; Progressive Metal & Refining Co., Milwaukee, Wis.

Various products are made by smelters and refiners from scrap aluminum. One sample of pig aluminum, which was made from clean sheet-aluminum clippings, shows the following analysis:

Analysis of secondary aluminum.

Aluminum	98.75
Copper	.16
Silica	.11
Iron	.56
Manganese	.42
	100.00

The standard No. 12 alloy is the best known and most widely used of aluminum casting alloys. It contains a minimum of 92 per cent aluminum and from 7 to 8 per cent copper. Another alloy made by a large secondary aluminum smelter contains 4 per cent zinc, 8 per cent copper, and the remainder aluminum. Some of the reasons for defective aluminum castings are given by L. M. Brile.[1]

Aluminum chips from castings used in the manufacture of automobiles have become a large source of secondary aluminum. By the old methods of treatment the loss in remelting such chips was sometimes as much as 40 per cent. A publication issued by the United States Bureau of Mines[2] gives an account of experiments which resulted in reducing such losses to as little as 10 per cent.

On account of the difficulty in obtaining virgin pig aluminum, a considerable quantity of scrap aluminum was purchased directly by foundries instead of being purchased and refined by secondary smelters. For this reason it is deemed advisable to reproduce the following article, written by Charles Vickers and published in the Daily Iron Trade and Metal Market Report of August 12, 1918:

Scrap aluminum.—New sheet aluminum clippings must consist of new sheet aluminum and cuttings, must be free from oil, grease, and any other foreign substances, and must be guaranteed not less than 98 per cent pure aluminum.

When sheet aluminum is compressed into briquettes little difficulty is experienced in using it for making aluminum castings, but it is difficult material to melt when loose, as the crucible contains only a small amount at each charge. A great deal of attention, therefore, is required, and considerable metal always is spilled into the furnace. Hence sheet clippings should always be shaped into massive forms. It is fairly good material for making castings when it has a purity of 98 per cent, but it is similar to aluminum wire in that respect, as the specifications for this material require a purity from 98 to 99 per cent also. Aluminum wire is not difficult to charge for melting provided that when cut into suitable lengths it is not permitted to untwist if it be in the form of cable. Wire of single strand has to be coiled or compressed into bundles; otherwise it is a most tedious operation to melt it into ingots or castings.

The cost of melting aluminum clippings or wire will depend upon their physical condition. In the case of loose wire in short lengths, produced by the untwisting of cut aluminum cable, the melting cost in a careful test of 500 pounds of wire amounted to $2.62 per 100 pounds, and this was when labor was much cheaper than now. Included in this cost were labor, crucibles, fuel, and loss, but the labor cost was more than all the other costs combined. The loss was 7 per cent. It will be realized that if finely divided aluminum is to be melted economically, some method of forming it into packages of massive size is essential.

The metal, either wire or clippings, forms a good basic metal for ordinary castings and can be alloyed the same as the ingot metal. But owing to the presence of a considerable amount of impurities, trouble from excessive shrinkage of the alloys is likely to arise more often than would be the case if pure aluminum were used. Unless the material be in good shape for charging into the pots, its cost when melted would be near that of pure aluminum ingot, and this must be taken into consideration when deciding upon the particular kind of raw material to use for the work in view.

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[1] Metal Industry, February, 1916, pp. 86–87.

[2] Gillett, H. W., and James, G. M., Melting aluminum chips: Bur. Mines Bull. 108, 1916.

The temperature of the aluminum should be kept at about a red heat, and after the crucible is as full as desired, a flux of zinc chloride should be used to disentangle the oxide from the metal.

The scrap metal specifications insist that aluminum castings shall be free from iron, babbitt, brass, and any other foreign substance and must not exceed 2 per cent of oil and grease.

Aluminum alloys may be divided into two groups, those that contain zinc and those that do not. The first group may contain any amount of zinc from 1 or 2 per cent up to 30 per cent, with or without copper. The second group consists of alloys of copper and aluminum, with rarely more than 8 per cent copper, this latter alloy being known as No. 12 aluminum. Since both these groups are used indiscriminately for making aluminum castings, it is obvious that an assortment of scrap will contain alloys both with and without zinc content. The result is that when melted it is impossible to keep the composition at all regular. Consequently, this chance must be taken when using this type of scrap metal.

Aluminum zinc alloys are not considered suitable for certain classes of aluminum castings, although in general they are stronger than the alloys of aluminum with copper. The aluminum zinc alloys shrink and check more than the aluminum copper alloys; and the higher the content of zinc in the alloy, the more the tendency to shrink, until with over 30 per cent of zinc a peculiar shrinkage trouble is likely to manifest itself on the lower parts of castings of heavy section. The result is that zinc is considered most undesirable in scrap aluminum, and if some easy and inexpensive method could be devised whereby the zinc could be eliminated from aluminum scrap it would be a boon to the scrap metal trade. The best that can be done at present is to alloy the aluminum with zinc-free metals to bring the zinc content down to a point where, while undesirable, it is not harmful for most purposes.

For special purposes, scrap aluminum castings are undesirable, but examples of castings where this material can be used to good advantage are numerous, as it is considerably cheaper than new aluminum or scrap rolled material. In the case of unimportant castings of such section as are easy to cast, scrap aluminum is a desirable and economical material to use, and it can be run directly into castings after it is melted down. In some cases, additional zinc can be added further to cheapen the alloy. This is not difficult provided the scrap comprises castings of similar sort, like gear casings, instead of being a heterogeneous mixture. In such a case the scrap will be of similar composition; and if a trial heat be made with zinc addition, there will be little difficulty in deciding the amount of zinc to be added to cheapen the mixture.

Scrap aluminum castings are easy to melt and recast, as the metal is broken with ease and easily charged into the crucibles. The only thing to be careful of is to keep the temperature below a cherry red between the intervals of charging new metal. When the crucible is as full as desired, a small piece of zinc chloride should be added and stirred into the metal to clear the surface. When the alloy contains much zinc, a little sal ammoniac has been found to do good, as this is the best flux to use in the case of zinc. For zinc aluminum, chloride of zinc is the best flux.

SECONDARY NICKEL.

An effort was made for the first time in 1916 to ascertain the quantity of secondary nickel recovered as nickel or in alloys. The reports received in 1918 showed that 1,393 tons of nickel was recovered in that year; a considerable part of which was obtained from clean new scrap. This does not include any nickel in scrap ferrous alloys nor the monel metal recovered from secondary sources made by the International Nickel Co. The monel scrap remelted by the International Nickel Co. is included with matte and ore, and no separate recovery is attempted. The quantity of nickel in matte, oxide, ore, etc., imported into the United States in 1918 was 73,207,147 pounds, most of which was from the Sudbury district, in Ontario. The nickel-copper matte imported is partly refined and partly smelted to make monel metal. Of the refined nickel produced about 60 per cent is used in nickel steel, 30 per cent in white metal alloys, 5 per cent in anodes for plating, and 5 per cent for miscellaneous purposes including the manufacture of salts and other chemical compounds. No direct production of nickel from American nickel ores is known to have been made in the United States in recent years, but an equivalent of about 441 short tons of nickel was saved in 1918 as a by-product in the electrolytic refining of copper.

The Missouri Cobalt Co., of Fredericktown, Mo., mined ore in 1918 which contained lead, copper, nickel, and cobalt. A new refinery was completed at which the residues returned from the ore shipped to sulphuric acid plants will be treated for the nickel and cobalt content.

As the greatest use for nickel is as an alloy in steel, and the secondary recoveries of nickel reported to the Geological Survey in 1918 were obtained solely from nonferrous scrap, it is evident that the 1,393 tons of nickel reported form a small portion only of the nickel in alloys recovered and reused. The secondary nickel reported in 1918 was nearly all recovered from old nickel anodes, nickel silver, and monel metal. Analyses of various nickel alloys have been published by the United States Geological Survey.[1]

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[1] Hess, F. L., Nickel: U. S. Geol. Survey Mineral Resources, 1915, pt. 1, pp. 763–765, 1917.

MANGANESE AND MANGANIFEROUS ORES.[1]

By D. F. Hewett.

INTRODUCTION.

The year 1918 brought the end of the war and also the culmination of many activities in the manganese industry. Domestic shipments of high-grade ore were 305,869 tons, or more than twice those of 1917, nearly 10 times those of 1916, and more than 30 times those of 1915. The rate of production of ore attained the maximum during the third quarter of the year, but after the armistice was signed it declined rapidly.

Imports of ore were 491,303 tons, or 138,669 tons less than in 1917. Imports of ferromanganese in 1918 were 27,168 tons, compared with 41,969 tons in 1917, and were the lowest since 1904. With the end of the year most of the governmental activities that affected the industry were abandoned and a rapid readjustment to the demands of peace conditions was begun.

If most persons in 1914 thought that the ending of the war would permit a gradual return to the general conditions that preceded it there are probably very few persons now who do not think that in most industries the war has brought many permanent changes. The war showed that domestic manganese deposits could supply a fair part of the Nation's needs—about 35 per cent. Although the war's end brought a sudden collapse to the mining of domestic manganese it is too early to say whether this is temporary or will persist and leave the industry much as it was in the years before 1914. The war impressed upon many persons the advantage of potential if not present national independence in the supplies of essential minerals and greatly increased Government control over all industries. There is a possibility that public opinion may demand a high degree of independence in such mineral supplies, and if some industries can not survive competition under the new peace conditions that same public opinion may urge the protection of these industries by tariffs or otherwise.

In the hope that the war record may interest those engaged in the industry and perhaps be valuable in a future consideration of the efficient control of an industry in war time, a summary of the manganese industry and the development of Government and trade activities during the war is here presented.

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[1] The statistical tables in this report were compiled by Miss H. M. Meyer, of the United States Geological Survey.

SUMMARY OF THE DOMESTIC MANGANESE INDUSTRY.

BEFORE AUGUST, 1914.

GENERAL STATEMENT.

Although manganese deposits are unusually widespread throughout the world, Russia, India, and Brazil supplied about 95 per cent of the world's production from 1910 to 1913. Thus, of the six nations that produced 96 per cent of the world's steel in 1913 only Russia possesses manganese deposits adequate to supply the domestic steel industry without development of new processes for steel making.

Of the other important steel-making countries, Germany, Great Britain, France, and Austria imported practically all the manganese ore they needed and manufactured manganese alloys, whereas the United States alone imported half of its needs as ore and half as ferromanganese. Of these countries only the United States was able to make important contributions from domestic deposits of manganese during the war.

REQUIREMENTS.

In the United States more than 95 per cent of the manganese used in the industries is added to steel in the form of alloys—ferromanganese and spiegeleisen. With the recent great development of the internal-combustion engine, the demand for high-grade manganese ore for use in making dry batteries has steadily risen, so that in 1917 the annual requirement for that industry was about 25,000 tons.

The manganese needs of the steel industry may be expressed in terms of (1) manganese metal in the form of alloys, (2) manganese alloys—such as ferromanganese and spiegeleisen, (3) manganese and manganiferous ores, or (4) partly of alloys and partly of ores. Commonly, needs are expressed in terms of ores, but as the average consumption of manganese metal in making a ton of steel is about 14 pounds and as the grades of ores as well as of alloys vary, it frequently serves a better purpose to express needs in terms of manganese metal in the form of alloys. Furthermore, aside from certain economics that may be practiced in using alloys, it has long been known that in making steel within certain ranges of carbon content, spiegeleisen may be partly substituted for ferromanganese. If now needs are expressed in terms of high-grade and low-grade ores, the possibility of such substitution may be overlooked.

The following table shows the quantities of metallic manganese as well as of alloys and ores that are needed to make certain definite quantities of steel. The estimates are based upon the average quantities used during the three years 1916, 1917, and 1918.[1]

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[1] See also Ellicott, C. R., Iron Trade Rev., June 6, 1918, pp. 1439–1441.

Domestic requirements of manganese expressed as metallic manganese, manganese alloys, and manganese ores, on the basis of three different rates of production of steel, in gross tons.

Assumed total production of steel	40,000,000	45,000,000	50,000,000
Open-hearth steel	31,200,000	35,000,000	39,000,000
Bessemer steel	8,800,000	10,000,000	11,000,000
Total metallic manganese needed in ferromanganese and spiegeleisen	260,000	292,000	325,000
Metallic manganese in ferromanganese	217,620	244,404	272,025
Equivalent as 80 per cent ferromanganese	272,000	305,000	340,000
Equivalent manganese ore, 95 per cent imported	644,000	724,000	849,000
Equivalent manganese ore, 66 per cent imported [a]	683,000	880,000	979,000
Manganese ore for sundry other uses	50,000	50,000	50,000
Total manganese ore, 95 per cent imported	694,000	774,000	899,000
Total manganese ore, 66 per cent imported	733,000	930,000	1,029,000
Metallic manganese in spiegeleisen	42,380	47,596	52,975
Equivalent as 20 per cent spiegeleisen	211,900	237,980	264,875
Equivalent manganiferous ore (16 per cent manganese; hitherto all domestic)	378,000	425,000	473,000

[a] On account of its lower manganese and high silica content, 6 tons of domestic manganese yield only as much manganese as 5 tons of average imported ore.

SOURCES OF ORE.

From about 1890 to 1914 the United States was largely dependent upon foreign sources of manganese ore and alloys. As Russia, India, and Brazil have each supplied a large part of the imports from time to time, and as the reserves in each of these countries were known to be large, there was good reason in 1914 for believing that if one or even two of these sources were interrupted, the other could meet any demand that would probably arise.

Although deposits of high-grade manganese ore have been known in some of the States for many years[1] and one deposit in Virginia has produced as much as 160,000 tons, the meager annual production since about 1892 has come largely from a few small mines operated intermittently. Most of the known and productive deposits are in agricultural regions, more or less remote from established mining communities, so that even though the ores occur within 200 feet of the surface, a high degree of skill has rarely been shown in exploiting them. The rate of production of the mines that have yielded about 90 per cent of the total domestic output has been determined by the capacity of the mills in which the ores were cleaned or concentrated. Commonly, the investment in the mill exceeded that in the entire mining plant, and here and there that in the property as well. About 1914, therefore, manganese mining was known by well-informed persons to be a very hazardous business. Even after the industry had become very active in many localities in 1918, there were no producers' associations which could interpret the needs of the industry or to which consumers or the Government might readily turn to explain the current demands.

Deposits of low-grade or ferruginous manganese ore have been known in several parts of the United States for many years, notably at Leadville, Colo., and at Silver City, N. Mex. Explorations since 1905 on the Cuyuna range, Minn., have shown the existence of deposits of iron and ferruginous manganese ore; the exploitation of the iron ore has been vigorously carried on, but the marketing of the ferruginous manganese ore has been difficult because of its high content of silica and phosphorus.

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[1] Harder, E. C., Manganese deposits of the United States: U. S. Geol. Survey Bull. 427, 298 pp., 2 pls., 1910.

ORE TRADE.

Although a few brokers bought high-grade ore and sold it to the battery, glass, and chemical trades before 1914, the quantity was small in comparison with that which was imported and smelted to ferromanganese by the subsidiaries of the United States Steel Corporation, the only company in the United States then engaged in manufacturing ferromanganese. The price of manganese ore was largely determined by the schedules issued from time to time by those subsidiaries. In addition to the use of ore by the subsidiaries of the United States Steel Corporation, the New Jersey Zinc Co. has for many years made spiegeleisen from zinc residuum and sold it widely.

ALLOY INDUSTRY AND TRADE.

Both ferromanganese and spiegeleisen are made in the common type of blast furnace in which pig iron is made, and no special equipment is needed. In fact, it is not uncommon for an operating iron furnace to make successively pig iron, spiegeleisen, and ferromanganese merely by proper changes in the raw materials charged.

There is no record that the United States Steel Corporation has ever traded in alloys; apparently its subsidiaries have made only sufficient alloys for its needs. Except for the addition of one maker of spiegeleisen in 1913, the number of makers of ferromanganese and spiegeleisen had been practically constant for years. The so-called "independent" steel companies purchased largely through brokers most of the alloys they needed, and the alloys handled by brokers were imported chiefly from England, although during recent years a little was imported from Germany.

As there was only a small tariff on manganese alloys until the passage of the Underwood tariff bill of 1913, which permitted their free entry, the domestic prices were determined chiefly by the costs at which the alloys could be imported.

For some years, but principally since 1910, the American Iron and Steel Institute has included in its membership most of the makers of iron and steel as well as the makers of many articles in which these materials are extensively used. It collects many useful statistics concerning the iron and steel industry, and its annual meetings are devoted to discussions of the commercial and industrial problems of the industry. It is a powerful agency for stimulating unity of purpose and coherence among the makers of steel and steel products.

AUGUST, 1914, TO APRIL, 1917.

SOURCES OF ORE.

When the Dardanelles was closed in October, 1914, the Caucasus region of Russia ceased to be a source of the high-grade manganese ore on which the battery, glass, and chemical trades depended. The resulting shortage led to experimentation by which it was found that ores with as much as 2 or 3 per cent of iron and as little as 70 per cent of manganese dioxide could be used in making batteries without serious loss of efficiency. Considerable material that met these specifications was shipped from the Philipsburg district of Montana during the war, mostly in 1918.

Even though most of the ore from India is of better grade than that from Brazil, the shorter haul from Brazil to the points of consumption near the Atlantic seaboard led consumers to provide promptly for their needs from this source. Efforts were also made to get as much ore from the West Indies and Caribbean region as possible, and the deposits of Cuba were reopened after having been idle since 1909. Operators of new deposits in Costa Rica, Panama, and Porto Rico began to ship ore in 1916. During this period the prices offered for domestic ore were steadily increased to about four times those prevailing before 1914. The increases, however, lagged behind those of ferromanganese and were not so large per unit of contained manganese. The higher prices aroused interest in domestic deposits, and many old deposits were reopened, particularly in Virginia, Arkansas, and Georgia. Prospecting and exploration in most of the other States did not begin until 1916, however, and became intensive during the summer of 1917. Most of the deposits that were important sources of production in 1918, especially in Montana and Nevada, were discovered during this period. Although the shipments of high-grade ore in 1916 were more than three times those in 1915, which in turn were three times those in 1914, they were so much less than the shipments in 1917 that one is led to conclude either that the rate of increase measures the period that must elapse between discovery of deposits and production from them or that the prices offered were not so great an incentive as the realization of the Nation's need in time of war. There can be no doubt that in April, 1917, few, even among the well informed, would have been willing to assume that the successive annual outputs in 1917 and 1918 would each be about three times that of the preceding year. Curiously the number of shippers of high-grade ore for each successive year from 1915 to 1918 was about two and a half times that of the preceding year.

ORE TRADE.

As the prices offered for ore and the quantity of ore imported increased, many brokers entered the field, buying and selling both domestic and foreign ores, particularly the latter. Inability to import customary quantities of ferromanganese induced several steel companies to make the alloy, and for the first time, during recent years at least, several companies engaged in the business of making ferromanganese in blast furnaces for sale to the small steel companies. One of these companies operating a furnace near Chicago and disadvantageously situated with respect to imported ore, began in 1917 to issue regularly schedules of prices for domestic ores which permitted it to compete successfully for western ores and to become the principal consumer of these ores during 1917 and 1918. The Noble Electric Steel Co. also, having a cheap source of electric power at Heroult, Calif., began in 1914 the manufacture of ferromanganese on a commercial scale and therefore made a market for local ores.

In February, 1917, the Southern Manganese Corporation began the construction of an electric furnace plant for making ferromanganese at Anniston, Ala., and in 1918 this furnace provided a local market for large quantities of ore from the Southeastern States.

During this period much more domestic ore was consumed by the new makers of ferromanganese than by the companies previously established in the business.

ALLOY INDUSTRY AND TRADE.

During the period from 1914 to 1917 increases in the price of ferromanganese and spiegeleisen coincided with the events that marked the enlargement of submarine warfare, which made hazardous the importation of ore into England and the exportation of ferromanganese to the United States. As these increases in the price of alloys were not promptly reflected by similar increases in the price of ore, there can be no doubt that throughout part of the period, especially in 1916, there was unusual profit in converting the ore to alloy. The great increase in the number of makers of alloys during the period was undoubtedly caused by the prospect of unusual profit. It is noteworthy also that several well-established brokers, acquainted with the processes of obtaining supplies of ore from the available foreign sources, entered into arrangements with furnace owners by which the profits of converting ore to alloy were divided. With conservative steel makers contracting for future delivery of needed large supplies of foreign ore, especially from Brazil, and brokers associated with alloy makers seeking similar material, it is not strange that most of the makers of alloys should have overlooked domestic sources.

Although the trade had become accustomed to 80 per cent ferromanganese and 20 per cent spiegeleisen, several aggressive steel companies experimented during 1915 and 1916 with alloys of uncommon composition. One company, the Colorado Fuel & Iron Co., Pueblo, Colo., completely substituted 32 per cent spiegeleisen, made locally from domestic ore, for imported 80 per cent ferromanganese; and another, the Lackawanna Iron & Steel Co., Buffalo, N. Y., experimented with low-grade spiegeleisen and 45 per cent ferromanganese. These experiments undoubtedly played a part in the radical and widespread revision of alloy grades in April, 1918.

APRIL, 1917, TO DECEMBER, 1918.

GOVERNMENT, STATE, PROFESSIONAL, AND TRADE ACTIVITIES.

The entrance of the United States into the war marked the beginning of a number of activities in the manganese industry by existing and new Government, State, trade, and professional organizations, all of which were planned to meet the unusual conditions in the industries created by the war.

In April, 1917, the existing Government organizations that were authorized and prepared to consider the problems of the mineral industries were the United States Geological Survey and the Bureau of Mines of the Department of the Interior, the Bureau of Foreign and Domestic Commerce of the Department of Commerce, and the Council of National Defense.

The Geological Survey, created in 1879, had made comprehensive studies of the mineral resources of the country and had collected and published annually and for some products monthly comprehensive statistics concerning the production and shipments of many raw minerals as well as of some metals and manufactured products. The United States Geological Survey worked in close cooperation with many State geological surveys and therefore possessed or had access to a wealth of detail concerning mineral resources and the mineral industries.

In August, 1914, soon after the outbreak of war in Europe, the Director of the Survey and the available assistants in Washington compiled a bulletin [1] which summarizes the sources of American supplies and indicated the degrees of our independence in minerals. This was followed in 1917 by more exhaustive pamphlets on each of the mineral commodities.[2] In April, 1917, field studies of manganese deposits were begun, which aimed to determine the immediately available and the prospective reserves of each grade of manganese ore and the probable rate of production in the near future. These studies were gradually extended throughout all the States, and so far as possible were made in cooperation with the existing State organizations. When the armistice was signed in November, 1918, most of the known deposits had been examined.[3]

The Bureau of Mines, created in 1910, had made many studies of mining, milling, and metallurgic technique as well as of safety devices and methods. After a preliminary field survey of the problems of production and utilization of domestic manganese ores from May to August, 1917, engineers were sent to most of the productive fields to aid in improving mining and milling practice, and to smelting and steel works to determine methods of economical and efficient use of the ores and alloys. The results of these studies are recorded in a series of reports published during 1918 and 1919 under the general title "War minerals investigations," as follows:

No. 4. Royster, P. H., The national importance of allocating low-ash coke to the manganese alloy furnaces.
No. 5. Royster, P. H., Production of ferromanganese in blast furnaces.
No. 6. Royster, P. H., Production of spiegeleisen in blast furnaces.
No. 7. Weld, C. M., Review of the manganese situation.
No. 9. Newton, E., Problems involved in the concentration and utilization of domestic low-grade manganese ore.
No. 10. Gillett, H. W., and Williams, C. E., Electric smelting of domestic manganese ore.
No. 11. Hoyt, S. L., The use of manganese alloys in open-hearth steel practice.
No. 12. Christianson, P., and Hunter, W. H., The Jones process for concentrating manganese ores.
No. 13. Weld, C. M., and Crane, W. R., Cost of producing ferro-grade manganese ores.
No. 16. Phalen, W. C., Uses of manganese other than for steel making.
No. 17. Crane, W. R., Preparation of manganese ores.

The Bureau of Foreign and Domestic Commerce, created in 1912, has collected statistics concerning the source, quantity, and destination of imported and exported materials, raw as well as manufactured.

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[1] Smith, G. O., Our mineral reserves—how to make America industrially independent: U. S. Geol. Survey Bull. 599, 1914.

[2] Smith, G. O., and others, Our mineral supplies: U. S. Geol. Survey Bull. 666 (issued first as separate chapters, 1917).

[3] For a preliminary review of this work, see Harder, E. C., and Hewett, D. F., Recent studies of domestic manganese deposits: Am. Inst. Min. and Met. Eng. Trans., preliminary separate, 1919.

The Council of National Defense, established by act of Congress in August, 1916, was charged with the "coordination of industries and resources for the national security and welfare" and with the "creation of relations which will render possible in time of need the immediate concentration and utilization of the resources of the Nation." It was composed of six Cabinet officers and an advisory commission of seven other persons, and by April, 1917, many advisory committees had been appointed. Naturally, a number of these committees were drawn from officials of the principal companies engaged in production and manufacturing and from trade organizations. Thus the committee on production of steel included officials of several steel companies, and the subcommittee on ferroalloys was identical with a similar committee of the American Iron and Steel Institute.

In May, 1917, the American Iron and Steel Institute, interested primarily in the steel and alloy trades on behalf of its members, began to collect and distribute to its constituents monthly reports on the receipts, consumption or sales, and stocks of manganese ore and ferromanganese. It planned to make a survey of the distribution of domestic deposits and the prospect for increased production, but in June it relinquished this inquiry to the United States Geological Survey. The inquiry showed that domestic mines were vigorously responding to the increased demand for high-grade ore and that there was a probability that the shipments for the year 1917 would be about 10 per cent of total needs, in contrast to 1 per cent or less in recent years. This was the first of the quarterly summaries and forecasts that were prepared by the Geological Survey until July, 1919. Probably the most important result of this inquiry was the indication that new deposits were being found in many parts of the United States, especially in the Rocky Mountain region and on the Pacific coast, and that any forecast of shipments based entirely upon the trend of recent shipments would be very misleading and probably lower than the actual shipments.

An organization that was to play an important part in the manganese-ore industry and the legislation affecting it was formed in June, 1917. It was known as the War Minerals Committee and included W. Y. Westervelt, chairman, representing the American Institute of Mining and Metallurgical Engineers and the Mining and Metallurgical Society of America; W. O. Hotchkiss, representing the Association of American State Geologists and the National Research Council; David White, representing the United States Geological Survey; and A. G. White, representing the Bureau of Mines.

The committee held meetings in Washington frequently during June, July, and August, 1917, that were devoted to studies of foreign and domestic mineral supplies, requirements, and possible substitutes, as well as the problem of transportation and uses. It made the first attempt to give widespread publicity to the relation between available ships and the maintenance of adequate supplies of essential minerals and related manufactured products. As the result of later meetings in November and December, 1917, and January, 1918, a bill was introduced into Congress that provided for giving comprehensive control of the supplies of most minerals to a mineral administrator, to be appointed by the President.

In order to make available to the new and inexperienced operators of manganese deposits in Virginia a better class of engineering assistance than they could pay for, the committee arranged through the secretary of the American Institute of Mining and Metallurgical Engineers and the Bureau of Mines to have a party of engineers visit the mines. It also attempted, particularly at the meeting of the American Institute of Mining and Metallurgical Engineers in St. Louis in October, 1917, to make it widely known among American mining engineers and geologists that there was great need for domestic supplies of certain raw minerals, especially manganese and chrome ores and pyrite.

Soon after the United States declared war on Germany the committees of the Council of National Defense called for special reports on many industries. In May, 1917, the Division of Raw Materials requested the Bureau of Foreign and Domestic Commerce to prepare statistical reports on the ferroalloy ores, manganese, chromium, and tungsten, showing recent monthly imports and sources, quantity and destination of exports, and apparent consumption. In September, 1917, it also requested the Geological Survey to prepare a report on the possibility of restricting imports of manganese ore in the near future. Having access to recent reports from geologists in the field and from the operators that indicated great increase in domestic production of all grades of ores, the Geological Survey was able to recommend the program of imports for 1918 shown below. To permit a comparison, the actual imports for the year 1918 are shown also.

Recommended and actual imports of manganese ore into the United States in 1918, in tons.

Country.	Recommended.	Actual.
Brazil	340,000	345,877
Cuba	50,000	82,974
Panama	5,000	5,697
Costa Rica	15,000	9,680
Others	None.	47,165
	410,000	491,373
Ferromanganese	None.	27,168

The estimate made in 1917 was little more than a guess, and at the time few considered it sufficient to meet needs. Actually, it was not much less than the imports received under a program of import control made six months later. As the surplus stocks of manganese ore and alloys steadily increased from April until November, 1918, the 410,000 tons of imported material recommended by this program obviously would have been sufficient to meet needs and maintain stocks.

The act that had the most far-reaching effect in the manganese industry during the war was the formation of the Mineral Imports and Exports Committee of the Shipping Board in January, 1918, with C. K. Leith as chairman and J. E. Spurr as advisory member. By Executive order early in February, 1918, the War Trade Board, which was created out of the Bureau of Export Licenses in June, 1917, was authorized to use its licensing power to control imports. The Shipping Board, acting upon the advice of its committee, was thereby enabled to conserve shipping by restricting imports. Nitrate from Chile, pyrite from Spain, and manganese ore from Brazil and India made up a large part of the quantity of minerals imported, and the committee was led to suspect that substantial reductions might be made. In January the committee requested estimates of the probable production and needed imports of manganese ore from several Federal and trade organizations as well as from informed individuals.

In the period from September, 1917, to January, 1918, the advisory committees of the Council of National Defense ceased to exert a powerful influence in the field of industry, and the War Industries Board, first as a part of and later independently of the Council of National Defense, with B. M. Baruch as chairman, was given broad powers under Executive order for organizing the industries of the country to meet war needs. Thus, in planning to place a program of imports before the manganese industry, the Mineral Imports and Exports Committee, in cooperation with the War Industries Board, during March, 1918, called meetings of the consumers of manganese ore, as represented by the ferroalloy subcommittee of the American Iron and Steel Institute and the producers. After many conferences the following program of imports was recommended by the committee:

High-grade ore (more than 40 per cent of manganese):	Tons.
Domestic (estimated)	175,000
Cuba	100,000
Panama and Costa Rica	20,000
Brazil	345,000
	640,000
Lower-grade ore (15 to 40 per cent of manganese, all domestic)	520,000
Zinc residuum (domestic)	175,000
Ferromanganese (to be imported)	None.

This program was later slightly modified so as to permit the importation of 12,000 tons of ferromanganese and sufficient manganese ore from Brazil to make up certain losses, such as that caused by the disappearance of the steamship *Cyclops*, which carried 10,000 tons of manganese ore.

Meanwhile the prospect of a reduction in imports of manganese ore drew the attention of many members of the steel trade to substitutes and methods of conservation. Several plans were offered, but that which was finally urged upon the members of the American Iron and Steel Institute in a letter signed by its president early in April, 1918, provided for reducing the grade of standard ferromanganese from 80 to 70 per cent of manganese, and that of spiegeleisen from 20 to 16 per cent of manganese. In the announcement of the new grades the members were urged to substitute available grades of domestic ore for the foreign ore recently used. The calling of a meeting of the metallurgists, chemists, and other technical members of the staffs of the steel companies at Pittsburgh, May 7, 1918, was more important, however, because it brought forcibly to the attention of those who were actually using the materials the serious nature of the problems of conserving the supply of manganese ore and alloy.

The situation thus created led to the adoption of several rather different plans by the consumers of ore. The great increase in production of spiegeleisen during 1918 shows clearly that many steel companies must have substituted spiegeleisen for ferromanganese to a greater extent than many thought possible before. There was therefore a great increase in demand for low-grade ores, which the country was well prepared to produce. Other companies substituted 60 and 70 per cent for 80 per cent ferromanganese, and, in order to obtain the proper ratio of iron and manganese, used large quantities of manganese ores containing 15 to 30 per cent of manganese, which were smelted with the high-grade imported and domestic ore.

The importance of the ferroalloy industries and the many and frequent readjustments that were taking place in them led to the creation in March, 1918, of a section of ferroalloys in the War Industries Board, with H. W. Sanford as chairman. In June C. D. Tripp, a maker of ferromanganese, and in September C. M. Weld, mining engineer of the Bureau of Mines, were added to the section. In May, 1918, the Mineral Imports and Exports Committee of the Shipping Board, having completed a program of imports for the year 1918, and submitted a report, was dissolved, and its chairman became mineral adviser to the chairman of the War Industries Board.

The shortage of many materials during the war and the advantage of prompt delivery produced extraordinary and rapid fluctuations in prices of materials. The diagram in figure 10 shows that the price of ferromanganese rose rapidly during 1916 and 1917 to ten times that of the first half of 1914, but that the increases in price of ore lagged from six to eight months behind the price of the alloy. Even though the advances in price of ore and alloy were about equal during the period from December, 1917, to March, 1918, or six times the prices in 1913, there were many complaints from producers of ore that prices of ore should be higher. As in many other industries these complaints led to trade agreements by which the prices of both ore and ferromanganese were practically fixed. On May 28, 1918, the War Industries Board announced that it had approved an agreement between the members of the American Iron and Steel Institute to pay the schedule of prices set forth on pages 632–633. Although no agreement concerning the price of ferromanganese was ever announced, the price did not fluctuate appreciably until late in December, 1918, when it declined rapidly.

As noted elsewhere, the great increase in production of ore during 1917 and 1918 came from mines west of Colorado, where freight rates to points of consumption ranged from $7.50 to $15 a ton. When freight rates throughout the country were increased 25 per cent in June, 1918, many complaints were made by producers of ore that the new rates would greatly curtail shipment of ores from western mines. After a conference of members of the Shipping and War Industries boards, the Geological Survey, and the Bureau of Mines, the United States Railroad Administration was requested to consider a plan for reducing rates on manganese ore from Western States. In August new rates were announced on manganese ore from the Western States to the principal consuming centers in Illinois, Pennsylvania, and Alabama. The new rates from Pacific Coast States were slightly lower than those in effect before June, 1918, but several rates on material from Colorado were slightly higher.

From June, 1918, when the policy of restricting imports was beginning to be effective, to November, when the armistice was signed, no new agencies were created that affected the tendencies of the manganese industry. The existing organizations, including the Shipping Board, the War Industries Board, the Bureau of Mines, and the United States Geological Survey, devoted their efforts largely to coordinating the work of collecting and, where desirable, disseminating information that would aid in meeting the program of reduced imports. Much space would be needed to give many of the details concerning this work. It included a wide range of activities such as careful studies of the reserves of domestic ores of each grade, current and prospective rate of production, maintenance of skilled labor at mines as well as supplies and equipment, studies of mining and milling technique and costs, maintenance of car supply, readjustments of freight rates, encouragement of more efficient uses, and study of the problems of marketing.

No statement concerning the history of the domestic industry during 1917 and 1918 would be complete without a tribute to the energetic spirit of many prospectors, miners, and mine operators, through whose efforts the search for and exploitation of manganese deposits was carried throughout the United States. Many of these men were doubtless largely inspired by the prospect of financial success, and many were woefully ignorant of the risks of the ventures they undertook, but only a cynic could fail to recognize in many of them a sincere desire to use their specialized knowledge to make a contribution to the common cause of their country, even though the chances of the game financially were against them. A simple calculation will show that largely through their efforts during 1918 alone the importation of about 180,000 tons of foreign manganese ore was avoided and consequently 50,000 tons of ship capacity was diverted to uses more directly related to winning the war.

WAR MINERALS MEASURES IN 1917 AND 1918.

The term "war minerals" was first used early in 1917 to include those minerals that are necessary or highly useful in the industries for a supply of which the United States had largely depended upon foreign sources and of which there was a shortage due to the shipping situation during the war. It does not include all minerals useful in the arts of war, for most minerals have extraordinary usefulness during a war among highly industrial nations. It was commonly meant to include the common minerals from which the following elements or their useful compounds were obtained: Antimony, arsenic, chromium, graphite, manganese, platinum, potassium, sulphur, tin, and tungsten. The term was first given prominence early in 1917 by the War Minerals Committee, previously referred to.

It was widely known that the territory of the United States contained most of the raw materials needed for the industries of the country during war, such as coal, oil, iron ore, lumber, cotton, and wool. Although some persons believed that the known resources of several minerals were adequate either to meet a part of expected needs for a long period, or to meet them entirely for a shorter period, it was a difficult problem to determine how much could be produced in the near future and whether certain guaranties were not desirable to assure a greater production. There would be cause for apprehension concerning the supply if marine transportation were greatly reduced or if the United States were isolated. Only a few persons, including most engineers and members of related professional groups, appeared to appreciate fully the technical and financial problems of producing quickly the minerals of which important but undeveloped resources were known. The exploration and exploitation of most minerals demand considerable time and expenditure of money, and few competent persons will undertake to produce them without some assurance that the product can be marketed long enough or at prices high enough to assure the return of the capital. Prices of many minerals had risen since 1915, but it was widely suspected that when foreign supplies could be obtained prices would rapidly decline to those that prevailed before the war, and that this would probably be possible within a few months after the end of the war. During the summer of 1917 many persons came to believe that, rather than expecting private individuals to make the necessary investments to bring forth the greatly increased production of many war minerals that was desired, the Government itself should practically assume control of the industries and buy, sell, and make contracts for the purchase and sale of the ores and some of the products made from them. It was claimed that there was good reason to expect that much larger shipments would be made if mine operators were assured markets for at least two years in advance than if future prices were left subject to the fluctuations of passing demand and the possibility of an early ending of the war.

Interest in the matter finally led to the preparation of a bill by the War Minerals Committee, and, after conferences with many engineers and others interested in both production and consumption of the minerals, this bill was introduced into Congress in January, 1918. The bill provided for wide powers over the production and distribution of many minerals and metals by a system of licensing. It provided for the establishment of maximum and minimum prices and, under necessity, for the actual operation of mines and reduction plants by the Government. After hearings before the Committee on Mines and Mining of the House of Representatives during March and April, the bill was greatly revised and finally passed by that body. The new bill (H. R. 11259, 65th Cong., 2d sess.) provided for control over fewer minerals and metals and placed its administration in the hands of the Secretary of the Interior.

Hearings on the new bill were held by the Committee on Mines and Mining of the Senate during May. Some opposition to the plan to control any of the mineral industries had been developed during the hearings in March, but formidable opposition was developed in May, particularly among the consumers of ferroalloys. This opposition and other causes led to delay in reporting the bill out of the committee. The bill that was finally passed (No. 220, 65th

Cong.) and signed by the President October 5, 1918, provided that "by reason of the existence of a state of war, it is essential to the national security and defense and to the successful prosecution of the war, and for the support and maintenance of the Army and Navy, to provide for an adequate and increased supply, to facilitate the production and to provide for an equitable, economical, and better distribution of the following-named mineral substances * * * as the President may from time to time determine to be necessary for the purposes aforesaid and as to which there is at the time of such determination a present or prospective inadequacy of supply." In order to use the powers of the act it was obviously necessary to determine the "present or prospective inadequacy of supply." In respect to manganese ore, domestic production had steadily increased to the maximum of 90,738 tons during the third quarter of 1918, or at a rate that slightly exceeded the estimate made in March, and imports, particularly from India, were also larger than early estimates. These factors, taken with economies in the use of ore and alloys, led to an increase of stocks so that nine months' supply was available on the basis of the current rate of production of steel. When the armistice was signed, in November, 1918, contracts for steel were widely canceled and the consumers of manganese ores ceased to purchase ores. Many mine operators urged that the "war minerals act" be used to protect the domestic ore industry by placing a tariff on imports, which continued to enter the country from remote sources. As there was no "present or prospective inadequacy of supply," the act could not be so used.

Until October, 1918, the country looked forward to at least another year of war. Naturally many manganese mine operators found themselves in November with large as well as small investments in mines that were made in anticipation of a longer war. Such operators, with those of mines of other war minerals, especially chrome, pyrite, and tungsten, made strong appeals for aid, many claiming that they had been urgently requested by members of the War Industries and Shipping boards as well as by the Bureau of Mines and the United States Geological Survey to enter into or increase the production of the "war minerals."

These appeals were finally recognized by Congress by the passage of the war contracts act (Rept. 1144, 65th Cong., 3d sess.), which provided that "the Secretary of the Interior be, and he hereby is, authorized to adjust, liquidate, and pay such net losses as have been suffered by any person, firm, or corporation, by reason of producing or preparing to produce, either manganese, chrome, pyrites, or tungsten in compliance with the request or demand of the Department of the Interior, the War Industries Board, the War Trade Board, the Shipping Board, or the Emergency Fleet Corporation to supply the urgent needs of the Nation in the prosecution of the war." The sum of $8,500,000 was appropriated to pay such claims and defray the expenses of administration.

Acting under the authority of the act, the Secretary of the Interior has appointed a commission of three to administer it.

SUMMARY OF STATISTICS.

Manganese alloys and ore produced in the United States and imported from important foreign sources, 1890–1918, in gross tons.

Year.	Steel.	Ferromanganese.		Spiegeleisen.		Manganese ore.				
	Production.[a]	Production.	Imports.	Production.	Imports.	Production.	Total imports.	Imports from—		
								Russia.	India.	Brazil.
1890	4,277,071	....	....	....	....	19,287	34,154	....	....	....
1891	3,904,240	....	....	....	....	22,452	28,825	....	....	....
1892	4,927,581	....	....	....	....	13,613	58,572	....	....	....
1893	4,019,995	....	....	....	....	7,718	68,113	[b]36,070	(c)	....
1894	4,412,032	....	....	....	....	6,308	44,655	[b]28,300	....	(d)
1895	6,114,834	....	....	....	....	9,547	86,111	[b]55,987	....	....
1896	5,281,689	....	....	....	....	10,088	31,489	[b]3,600	....	....
1897	7,156,957	....	....	....	....	11,108	119,961	38,910	17,400	12,083
1898	8,932,857	....	....	....	....	15,957	114,885	46,396	5,944	17,031
1899	10,639,857	....	....	....	....	9,935	188,349	73,397	17,950	28,115
1900	10,188,329	(e)	(f)	(e)	(f)	11,771	256,252	132,121	10,650	54,451
1901	13,473,595	59,639	20,750	231,822	26,827	11,995	165,722	32,600	11,000	48,029
1902	14,947,250	44,526	50,388	168,408	68,813	7,477	235,576	3,338	64,170	102,550
1903	14,534,978	35,961	41,519	156,700	122,015	2,825	146,056	5,576	35,960	76,910
1904	13,859,887	57,076	21,813	162,370	4,623	3,146	108,519	11,959	10,200	66,875
1905	20,023,947	62,186	52,841	227,797	55,457	4,118	257,033	24,650	101,030	114,670
1906	23,398,136	55,520	84,359	244,980	103,268	6,921	221,260	13,805	154,180	30,260
1907	23,362,594	55,918	87,400	283,430	48,994	5,604	209,021	1,000	95,300	52,922
1908	14,023,247	40,642	44,624	111,376	4,579	6,144	178,203	250	143,813	17,150
1909	23,955,021	82,209	88,934	142,831	16,921	1,544	212,765	14,486	145,140	35,600
1910	26,094,919	71,376	114,228	153,055	25,383	[g]2,258	242,348	33,120	140,965	53,750
1911	23,676,106	[g]74,602	80,263	[g]104,013	20,970	[g]2,457	176,852	19,103	103,580	41,600
1912	31,251,303	[g]125,378	99,137	[g]102,561	1,015	[g]1,664	300,661	83,334	128,645	81,580
1913	31,300,874	[g]119,495	128,070	[g]106,980	77	[g]4,048	345,090	124,337	141,587	70,200
1914	23,513,030	[g]100,731	82,997	[g]76,625	2,870	[g]2,635	283,294	52,681	103,583	113,924
1915	32,151,036	[g]144,260	55,263	[g]114,556	200	[g]9,613	320,778	....	36,450	275,579
1916	42,773,680	[g]224,103	90,928	[g]182,837	....	[g]31,474	576,321	....	51,960	471,837
1917	45,060,607	[g]260,225	41,969	[g]189,241	3,968	[g]129,405	629,972	....	48,975	512,517
1918	44,462,432	[g]306,076	27,168	[g]263,861	1,969	[g]305,869	491,303	....	29,275	345,877

[a] According to American Iron and Steel Institute.
[b] Drake, Frank, The manganese ore industry of the Caucasus: Am. Inst. Min. Eng. Trans., vol. 28, p. 191, 1898.
[c] First shipment made from India.
[d] First shipments made from Brazil.
[e] Figures for ferromanganese and spiegeleisen combined prior to 1901.
[f] Figures for fiscal years only available prior to 1901.
[g] Marketed production.

SOURCES OF MANGANESE.

MANGANESE MINERALS.

Though manganese forms a part of about 100 minerals and is a relatively widespread element, practically all the manganese in commercial use is derived from material containing one or more of the first seven of the minerals named in the following table:

Principal manganese minerals.

Mineral.	Composition.	Percentage of manganese.
Polianite	MnO_2	63.2
Pyrolusite	$MnO_2.n\,H_2O$	60-63
Psilomelane	$MnO_2.(MnKBa)O.n\,H_2O$	45-60
Wad	Hydrous impure mixture of manganese oxides	5-50
Manganite	$Mn_2O_3.H_2O$	62.4
Braunite	$3\,Mn_2O_3.MnO.SiO_2$	69
Franklinite	$(FeZnMn)O.(FeMn)_2O_3$	10-19
Rhodochrosite	$MnO.CO_2$	47.56
Rhodonite (manganese pyroxene)	$MnO.SiO_2$	41.9
Tephroite (manganese olivine)	$2MnO.SiO_2$	54.3
Spessartite (manganese garnet)	$3MnO.Al_2O_3.3SiO_2$	33.3

MANGANESE ORES.

In the report on manganese ores in 1916,[1] a new classification of the manganese-bearing raw materials of the United States was adopted. It was the purpose of the new classification to group the raw materials according to manganese content so that the quantities of material capable of certain specific uses would be indicated. Thus, in restricting the term "manganese ore" to materials containing more than 40 per cent of manganese it was the intention to indicate that practically all material in this class was capable of being smelted to ferromanganese containing 80 per cent of manganese, the product which is made from a large part of such ore. The war brought about changes in practice in the making and use of manganese alloys, so that early in 1918 it seemed desirable to change the limits previously placed in the classification of the ores. The action that led to this change was the recommendation in April, 1918, by the American Iron and Steel Institute to its members who include the officials of practically every steel company in the United States, that ferromanganese with 70 per cent of manganese be used as far as practicable in place of the 80 per cent alloy, and that spiegeleisen with 16 per cent of manganese be used in place of the 20 per cent alloy, and, therefore, that alloys of the lower grades be accepted on contracts for the higher grades. The purpose of lowering the grade of ferromanganese from 80 to 70 per cent of manganese was to permit the wider use of domestic ores in making the alloy. Actually the grade of alloy which may be made from an ore depends largely upon the percentages of manganese, iron, and silica that are present. If a classification were to indicate truly the use to which the material could be put it should properly be based upon assigned limits to each of these ingredients. In the United States, however, there are few large deposits of manganiferous materials of any grade which appear to be capable of shipping regularly over long periods material which shows the narrow ranges in composition that much foreign material shows. The actual work required in a classification of the shipments from individual mines according to a system based upon the percentages of manganese, iron, and silica, is too great to permit its ready adoption by the industry. In spite of certain obvious objections, therefore, the adopted classification is based upon the manganese content alone.

The new classification aims to group materials that are capable of being used to make the grades of alloys adopted as a war expedient. It remains to be determined whether the steel industry will continue to make and use the new grades of alloys, or whether, when the supply of high-grade foreign ores is not hindered, the industry will demand the old grades. Probably many steel makers will return to the use of the old grades of alloys, but as some makers appear to be satisfied with the new grades it will serve a purpose to continue the classification of ore adopted during the war.

Materials with more than 35 per cent of manganese will be considered manganese ore. If the manganese in such materials is present as one of the common oxides, it is possible for other substances to make up about 45 per cent of the total. On the other hand, if the manganese is present as carbonate, only 27 per cent of other substances may be present. During 1917 large quantities of oxide material were marketed from Arizona, California, and Montana, which contained more than 16 per cent of silica, and some mines report shipments containing as much as 27 per cent of silica. The iron content of manganese ores from most of the States is low—generally from 2 to 5 per cent—but material from several districts, especially Bisbee, Ariz., and Lake Valley, N. Mex., ranges from 3 to 11 per cent and the average is close to 9 per cent. The average composition of the entire production during 1917—129,405 tons—as reported by the shippers was manganese, about 42.5 per cent; iron, 2.8 per cent; silica, 14 per cent; natural basis, but moisture not reported.

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[1] Hewett, D. F., U. S. Geol. Survey Mineral Resources, 1916, pt. 1, pp. 733–734, 1919.

Materials containing 10 to 35 per cent of manganese will be considered ferruginous manganese ore. In the report for 1916 the range for material under this class was 15 to 40 per cent of manganese. It should be stated that there is no natural basis for choosing the percentage that marks the dividing line between manganese ore and ferruginous manganese ore. Any such percentage must be arbitrarily chosen on the basis of the use to which the material is to be put. It is worthy of notice that although large quantities of both oxide and carbonate materials containing from 35 to 40 per cent of manganese were shipped from a number of States during 1917, relatively little material containing 25 to 35 per cent of manganese has been produced from domestic deposits. Most of the material that is classified as a ferruginous manganese ore, produced largely in Minnesota, Michigan, Nevada, and Colorado, contains from 14 to 25 per cent of manganese, from 25 to 35 per cent of iron, and from 8 to 20 per cent of silica.

The objection has been made that in some districts such material has long been known as manganiferous iron ore and that it will be confusing to restrict the name to material with 5 to 10 per cent of manganese, which was not widely mined and used until recently, and to apply a new name to material that was formerly known by the old name. In reply to this objection it may be stated that there is need for two terms and that the material containing more than 10 per cent of manganese is of greater interest and commonly derives more value from its manganese than from its iron content. Spiegeleisen containing 16 per cent of manganese may be made from most of the material that is produced in the United States at present, although less than one-third was so used in 1917.

Material containing 5 to 10 per cent of manganese is classified as manganiferous iron ore. The market for such material lies mainly with the makers of basic pig iron, so called because it is especially adapted to making steel by the basic open-hearth process. There is no record that any of this material is used for making spiegeleisen.

The term "manganiferous silver ore" is applied to those materials, either oxides or carbonates, that contain more than 5 per cent of manganese and sufficient silver to make them more valuable as a source of silver than of manganese. Such materials commonly contain from 5 to 45 per cent of iron, several per cent of silica and lead, and a little gold and copper and are shipped to lead or copper smelters, where the silver, gold, lead, and copper are recovered and the manganese aids in making a more fusible and fluid slag.

Manganiferous zinc residuum is a product that commonly contains 12 to 15 per cent of manganese and is obtained by roasting franklinite, a mineral found only in several deposits near Franklin Furnace, N. J.

MANGANESE AND MANGANIFEROUS ORES.

SHIPMENTS AND PRODUCTION.

Manganese and manganiferous ore shipped in 1915.

State.	Ore containing 35 per cent of manganese or more.			Ore containing 10 to 35 per cent of manganese.			Ore containing 5 to 10 per cent of manganese.		
	Number of shippers.	Quantity (gross tons).	Value.	Number of shippers.	Quantity (gross tons).	Value.	Number of shippers.	Quantity (gross tons).	Value.
Alabama	1	200	(a)						
Arizona:									
Used for fluxing				1	1,452	(a)			
Used for other purposes	1	339	(a)						
Arkansas	7	1,288	$13,135	3	2,655	$8,742			
California	6	2,563	29,004						
Colorado:									
Used for fluxing				13	10,799	16,946	8	[b]4,166	$2,656
Used for other purposes	1	150	(a)	4	15,956	41,527			
Georgia	4	3,168	33,927	1	676	(a)			
Minnesota				3	42,973	187,971			
Nevada:									
Used for fluxing				1	104,498	(a)			
Tennessee	1	150	(a)						
Texas	1	(a)	(a)						
Utah:									
Used for fluxing	1	55	(a)						
Used for other purposes	1	(a)	(a)						
Virginia	7	1,620	17,988	6	1,944	6,708			
Wisconsin							1	10,616	(a)
Undistributed		80	19,057			535,087			17,517
	31	9,613	113,111	32	180,953	796,981	9	[b]14,782	20,173

[a] Included under "Undistributed." Geological Survey not at liberty to publish.

[b] Includes 796 gross tons of ore containing less than 5 per cent of manganese.

Manganese and manganiferous ore shipped in 1916.

State.	Ore containing 35 per cent of manganese or more.			Ore containing 10 to 35 per cent of manganese.			Ore containing 5 to 10 per cent of manganese.		
	Number of shippers.	Quantity (gross tons).	Value.	Number of shippers.	Quantity (gross tons).	Value.	Number of shippers.	Quantity (gross tons).	Value.
Alabama	1	(a)	(a)						
Arizona:									
Used for fluxing				1	7,392	$39,904			
Used for other purposes	5	3,060	$113,060						
Arkansas	10	6,318	180,722	6	3,682	22,665			
California	6	6,136	122,592	1	139	(a)			
Colorado:									
Used for fluxing				15	7,405	17,986	10	[b] 8,858	$1,029
Used for other purposes	3	110	1,670	(c)	90,850	299,012			
Georgia	1	(a)	(a)	2	(a)	(a)			
Minnesota				5	193,257	685,875	3	47,146	104,887
Montana	6	6,418	37,978						
Nevada:									
Used for fluxing				1	122,429	(a)			
Used for other purposes	2	(a)	(a)						
New Mexico	1	(a)	(a)	2	16,068	(a)			
Pennsylvania				1	451	(a)			
Tennessee	3	429	8,380						
Texas	1	(a)	(a)						
Utah:									
Used for fluxing				1	(a)	(a)			
Used for other purposes	6	1,282	22,597	1	(a)	(a)			
Virginia	15	4,417	118,342	7	7,213	28,079	2	(a)	(a)
Washington	1	(a)	(a)	1	(a)	(a)			
Wisconsin							1	3,982	6,570
Undistributed		3,304	50,937		4,967	693,908		30,487	76,715
	61	31,474	656,278	[d] 44	453,853	1,787,429	16	[b] 90,473	189,201

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[a] Included under "Undistributed." Geological Survey not at liberty to publish.

[b] Includes 1,026 gross tons of ore containing less than 5 per cent of manganese.

[c] Not ascertained.

[d] Number of shippers in Colorado of ore for purposes other than fluxing not ascertained; therefore, not included in this total.

Manganese and manganiferous ore shipped in 1917.

State.	Ore containing 35 per cent of manganese or more.			Ore containing 10 to 35 per cent of manganese.			Ore containing 5 to 10 per cent of manganese.		
	Number of shippers.	Quantity (gross tons).	Value.	Number of shippers.	Quantity (gross tons).	Value.	Number of shippers.	Quantity (gross tons).	Value.
Alabama	3	264	$10,538						
Arizona:									
Used for fluxing				2	17,013	(a)	1	15,396	(a)
Used for other purposes	22	14,802	479,971	2	2,040	(a)			
Arkansas	13	10,140	448,511	11	9,100	$83,227			
California	40	14,196	328,501	4	152	1,760			
Colorado:									
Used for fluxing	1	54	(a)	17	14,166	23,799	14	[b]6,380	$10,719
Used for other purposes	1	60	(a)	14	104,315	269,284			
Georgia	13	3,614	89,888	10	13,281	118,368			
Michigan				1	52,198	(a)			
Minnesota				8	359,573	1,826,835	2	91,590	(a)
Montana	28	61,109	1,797,842	2	1,568	(a)			
Nevada:									
Used for fluxing				1	122,872	142,543			
Used for other purposes	6	3,450	91,907						
New Mexico	6	2,603	54,143	1	15,900	(a)			
North Carolina	2	102	(a)						
South Carolina	1	405	(a)	1	650	(a)			
Tennessee	13	1,996	75,066	2	83	(a)			
Texas	1	25	(a)	1	135	(a)			
Utah:									
Used for fluxing				1	100	(a)			
Used for other purposes	6	4,195	118,927	1	36	(a)			
Virginia	18	12,360	588,806	12	17,577	131,197	3	16,819	54,771
Wisconsin							[c]1	[c]200,327	(ac)
Wyoming	1	30	(a)						
Undistributed			25,622			439,279			602,083
	175	129,405	4,109,722	91	730,759	3,036,292	[c]20	[b,c]130,185	[c]369,769

[a] Included under "Undistributed." Geological Survey not at liberty to publish.

[b] Includes 141 gross tons of ore containing less than 5 per cent of manganese.

[c] Manganiferous iron ore from Wisconsin, containing approximately 5 per cent of manganese, not included in totals for United States.

Manganese and manganiferous ore shipped in 1918.

State.	Ore containing 35 per cent of manganese or more.			Ore containing 10 to 35 per cent of manganese.			Ore containing 5 to 10 per cent of manganese.		
	Number of shippers.	Quantity (gross tons).	Value.	Number of shippers.	Quantity (gross tons).	Value.	Number of shippers.	Quantity (gross tons).	Value.
Alabama	1	709	(a)	4	443	$8,424			
Arizona:									
Used for fluxing				2	4,772	(a)	1	6,082	(a)
Used for other purposes	35	17,612	$570,005	8	1,986	25,022			
Arkansas	21	7,731	354,235	19	9,173	93,525			
California	47	24,067	740,566	2	68	(a)			
Colorado:									
Used for fluxing				[b] 18	13,217	19,826	22	[c] 11,714	$17,571
Used for other purposes	4	4,821	180,246	[b] 14	99,137	548,714			
Georgia	12	6,679	284,615	11	9,510	56,983	2	1,266	(a)
Michigan				1	22,673	(a)			
Minnesota				13	630,827	3,295,090	6	229,869	947,767
Montana	37	199,932	4,623,378						
Nevada:									
Used for fluxing				2	80,096	(a)			
Used for other purposes	17	19,872	544,727	4	258	2,737			
New Jersey	1	64	(a)						
New Mexico:									
Used for fluxing				1	75	(a)	1	400	(a)
Used for other purposes	12	3,126	80,195	5	32,832	159,140			
North Carolina	1	315	(a)	1	30	(a)			
Oregon	1	198	(a)						
South Carolina	1	100	(a)	1	850	(a)			
South Dakota	1	31	(a)						
Tennessee	23	4,162	153,830	11	2,307	43,368	1	51	(a)
Texas	1	380	(a)						
Utah	10	5,100	140,038						
Virginia	21	10,928	500,528	15	7,859	103,058	2	4,917	(a)
Wisconsin							[d] 1	[d] 215,839	(a d)
Wyoming	1	42	(a)	1	50	(a)			
Undistributed			68,023			247,903			696,701
	247	305,869	8,240,386	[b] 126	916,163	4,603,790	[d] 35	[c][d] 254,299	[d] 1,031,789

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[a] Included under "Undistributed." Geological Survey not at liberty to publish.

[b] Seven shippers of flux in Colorado also are shippers of ores for other purposes in Colorado. These shippers do not duplicate in the total for the United States.

[c] Includes 1,684 gross tons of ore containing less than 5 per cent of manganese.

[d] Manganiferous iron ore from Wisconsin, containing approximately 5 per cent of manganese, not included in totals for United States.

Manganese and manganiferous ore produced in the United States, 1838 to 1918, in gross tons.[a]

Year.	Ore containing 35 per cent of manganese or more.	Ore containing 10 to 35 per cent of manganese.	Ore containing 5 to 10 per cent of manganese.	Year.	Ore containing 35 per cent of manganese or more.	Ore containing 10 to 35 per cent of manganese.	Ore containing 5 to 10 per cent of manganese.
1838–1879	43,860	....	....	1900	11,771	(b)	
1880	5,761	....	....	1901	11,995	(b)	
1181	4,895	....	....	1902	7,477	(b)	
1882	4,532	....	....	1903	2,825	(b)	
1183	6,155	....	....	1904	3,146	(b)	
1884	10,180	....	....	1905	4,118	(b)	
1885	23,258	(b)		1906	6,921	41,300	
1886	30,193	(b)		1907	5,604	103,844	
1887	34,524	(b)		1908	6,144	55,894	
1888	29,198	(b)		1909	1,544	68,654	
1889	24,197	(b)		1910	2,258	41,260	19,841
1890	19,287	(b)		1911	2,457	37,584	6,853
1891	22,452	(b)		1912	1,664	40,863	10,654
1892	13,613	(b)		1913	4,048	51,512	7,891
1893	7,718	(b)		1914	2,635	91,666	6,599
1894	6,308	(b)		1915	9,613	180,953	[c]14,782
1895	9,547	(b)		1916	31,474	453,853	[d]90,473
1896	10,088	(b)		1917	129,405	730,759	[e]130,185
1897	11,108	(b)		1918	305,869	916,163	[f]254,299
1898	15,957	(b)					
1899	9,935	(b)			893,734		

[a] Beginning with 1910, the figures represent ore marketed (or shipments).
[b] Manganiferous ore included in iron-ore figures.
[c] Includes 796 tons of ore containing less than 5 per cent of manganese.
[d] Includes 1,026 tons of ore containing less than 5 per cent of manganese.
[e] Includes 141 tons of ore containing less than 5 per cent of manganese.
[f] Includes 1,684 tons of ore containing less than 5 per cent of manganese.

MANGANESE ORE.

PRODUCTION.

The shipments of manganese ore in 1918 were 305,869 tons, valued at $8,240,386, or nearly two and one-half times the quantity and a little more than twice the value of shipments in 1917. The increase in value is smaller than the increase in quantity, because there was a great increase during 1918 in shipments of material containing 35 to 40 per cent of manganese that had a lower value than the average. The number of shippers of this grade of material was 247 in 1918, compared with 175 in 1917.

There were no extraordinary new discoveries reported during the year and most of the increase in shipments came from the Butte and Philipsburg districts in Montana and from several other districts in Nevada and California discovered in 1917. Nearly 90 per cent of the shipments were from mines in or west of Colorado. Shipments from this region were more than three times those of 1917, whereas those from the group of Southeastern States extending from Arkansas to Virginia were only about equal to those of 1917. The inability of the deposits of the Southeastern States to show an increase from 1917 to 1918, in spite of favorable location with respect to the markets, is due, as previously emphasized in the annual summaries of the industry to the dependence of the output on the capacity of the mills. Only five mills were operated in the Western States—at Philipsburg, Helena, and Butte, Mont.; near Eagle Point, Oreg.; and at Tombstone, Ariz.

IMPORTS.

The following table was compiled from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce:

Manganese ore imported into the United States, 1914–1918.

	1914		1915		1916		1917		1918	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons.)	Value.	Quantity. (gross tons.)	Value.	Quantity (gross tons.)	Value.
Argentina							6,600	$40,023	849	$39,127
Australia					488	$19,313			198	13,990
Belgium	450	$5,913								
Brazil	113,924	736,769	275,579	$2,240,837	471,837	7,139,821	512,517	8,578,296	345,877	10,174,138
British India	103,583	504,981	36,450	194,626	51,960	401,779	48,975	362,582	29,275	547,886
Canada	64	1,357	325	12,989	756	72,496	883	40,534	301	11,968
Chile						18	202	6,330	2,998	48,760
Costa Rica					1,244	38,703	7,163	211,601	9,680	290,853
Cuba			5,141	69,453	30,563	514,184	44,511	612,413	82,974	2,751,193
France	5	1,580								
Germany	1,713	92,273	258	23,590		16				
Greece					3,000	24,318				
Japan	40	1,320	2,810	106,434	5,196	163,491	2,745	85,538	709	30,337
Mexico					390	7,093	345	9,790	5,251	159,357
Netherlands	2,505	52,213	50	1,792						
Panama					10,498	265,772	5,202	163,120	5,607	262,520
Portugal					289	11,997				
Russia	52,681	490,331								
United Kingdom	8,321	136,206	49	4,730	100	7,178	805	152,084	4,362	612,638
All other	8	1,177	116	1,529			[a] 24	[a] 618	[b] 3,222	[b] 153,100
	283,294	2,024,120	320,778	2,655,980	576,321	8,666,179	629,972	10,262,929	491,303	15,095,867

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[a] Includes 4 tons, valued at $180, from British South Africa and 20 tons, valued at $438, from China.

[b] Includes 107 tons, valued at $3,422, from Ecuador; 20 tons, valued at $641, from Peru; 3,000 tons, valued at $146,909, from China; and 95 tons, valued at $2,128, from British South Africa.

PRODUCTION IN PRINCIPAL PRODUCING COUNTRIES.

Manganese ore produced in principal producing countries, 1913 to 1918, in metric tons.

Country.	Percentage of manganese.	1913	1914	1915	1916	1917	1918
North America:							
Canada	....	....	25	182	868	143	[a] 303
Costa Rica	37–48	....	....	....	[a] 1,263	[a] 7,278	[a] 9,845
Cuba	36–44	....	....	[a] 5,223	[a] 31,052	[a] 45,223	[a] 83,305
Mexico	40+	....	....	....	[a] 396	[a] 350	[a] 5,335
Panama	50±	....	....	....	[a] 10,666	[a] 5,285	[a] 5,696
Porto Rico	35+	....	....	....	[b] 749	[b] 1,208	[b] 1,372
United States	35+	4,113	2,677	9,767	31,978	131,475	310,763
South America:							
Argentina	....	....	....	....	....	[a] 6,705	[a] 863
Brazil	38–50	122,300	183,630	288,671	503,130	532,855	[a] 351,428
Chile	40–48	....	....	....	....	[a] 205	[a] 3,046
Ecuador	....	....	....	....	....	....	[a] 109
Peru	....	....	....	....	....	....	[a] 20
Europe:							
Austria	....	16,540	(c)	(c)	(c)	(c)	(c)
Bosnia and Herzegovina	....	5,800	(c)	(c)	(c)	(c)	(c)
France	30+	7,732	(c)	(c)	(c)	(c)	(c)
Germany	30+	760	(c)	(c)	(c)	(c)	(c)
Greece	....	556	(c)	(c)	(c)	(c)	(c)
Hungary	....	19,008	(c)	(c)	(c)	(c)	(c)
Italy	18–45	1,622	1,649	12,577	18,147	(c)	(c)
Russia	41–48	1,310,064	[b] 715,057	[b] 8,844	[b] 8,862	(c)	(c)
Spain	29+	21,594	13,144	14,310	14,171	57,474	(c)
Sweden	....	4,001	3,642	7,606	3,643	(c)	(c)
United Kingdom	30+	5,489	3,492	4,714	5,222	10,101	(c)
Africa:							
Gold Coast	....	....	....	....	(d)	(d)	(c)
Tunis	....	....	....	1,460	2,027	5,800	(c)
Union of South Africa	....	....	....	....	....	124	(c)
Asia:							
India	47–52	828,128	693,858	457,646	664,704	600,296	(c)
China	....	....	....	....	....	....	[a] 3,048
Japan	50+	18,305	17,077	25,808	7,863	(c)	(c)
Oceania:							
Australia	40+	27	6	203	496	....	[a] 201

[a] Imports into the United States. Production and exports not available.
[b] Exports.
[c] Not yet available.
[d] Shipments June, 1916, to November, 1917, 31,482 metric tons.

FERRUGINOUS MANGANESE ORE.

The shipments of ores containing 10 to 35 per cent of manganese in 1918 were 916,163 tons, valued at $4,603,790. The quantity was about 25 per cent larger than in 1917 and the value was about 52 per cent higher. The number of shippers increased from 91 in 1917 to 126 in 1918. The only important increase in shipments was from the mines of the Cuyuna range; shipments from mines in Colorado, Michigan, and Virginia were considerably smaller than in 1917. As in 1917, practically all of the shipments from the Leadville district were used in making manganese alloys.

Manganiferous silver ore shipped, 1907–1918, in gross tons.

Year.	Arizona.	Colorado.		Nevada.	New Mexico.	Utah.
		For fluxing.	For other purposes.			
1907	....	32,197	67,514	....	....	....
1908	....	35,581	15,973	....	....	....
1909	....	52,119	12,905	....	....	....
1910	....	55,770	....	....	....	....
1911	....	41,753	....	....	....	....
1912	....	48,618	....	....	....	....
1913	....	49,753	....	....	....	....
1914	....	37,781	2,100	....	....	....
1915	[a]1,452	14,965	15,956	104,498	....	55
1916	[a]7,392	16,263	90,600	122,429	....	27
1917	[a]32,009	20,546	104,169	122,872	....	100
1918	[a]10,854	24,931	99,110	80,096	475	....

[a] Ore containing more than 35 per cent of manganese sent to makers of manganese alloys not included.

Ferruginous manganese and manganiferous iron ores shipped from the Cuyuna district, Minn., 1913–1918, in gross tons.

Mine.	Ore containing 10 to 35 per cent of manganese.						Ore containing 5 to 10 per cent of manganese.						Total.
	1913	1914	1915	1916	1917	1918	1913	1914	1915	1916	1917	1918	
Algoma (Hoch)	......	192	7,600	23,000	[a]84,125	21,200	....	....	....	......	......	......	[a]136,117
Arko	......	......	......	......	......	733	....	....	....	......	......	......	733
Cuyuna Mille Lacs	[b]26,200	55,000	35,221	90,000	112,554	132,515	....	....	....	......	......	25,560	477,050
Ferro	......	......	......	14,710	([a])	57,261	....	....	....	......	......	......	[a]71,971
Hillcrest	......	......	......	......	......	......	....	....	....	2,712	9,590	20,242	32,544
Hopkins	......	......	......	......	......	36,651	....	....	....	......	......	......	36,651
Ida Mae	......	......	......	......	......	5,134	....	....	....	......	......	......	5,134
Joan, Nos. 1 and 4	......	......	......	......	8,375	27,931	....	....	....	......	......	......	36,306
Mahnomen	......	......	......	([c])	4,000	132,726	....	....	....	[c]43,000	82,000	175,648	437,374
Mangan, Nos. 1 and 2	......	......	......	30,329	52,290	67,796	....	....	....	......	......	4,679	155,094
Martin	......	......	......	......	......	349	....	....	....	......	......	1,073	1,422
Merritt, No. 1	......	......	......	......	33,180	78,555	....	....	....	......	......	......	111,735
Sultana	......	......	152	35,218	65,018	64,158	....	....	....	......	......	......	164,546
	26,200	55,192	42,973	193,257	359,542	625,009	....	....	....	45,712	91,590	227,202	1,666,677

[a] Shipments from Ferro mine included with Algoma mine for 1917. Not reported separately to the Geological Survey.

[b] Percentage of manganese not stated.

[c] Shipments from Mahnomen mine in 1916 averaged 5 to 14 per cent of manganese. Not reported in greater detail to the Geological Survey.

VALUE OF MANGANESE ORES.

In general the value of materials that contain manganese depends on the composition, the minerals present, and the condition or state of aggregation of the material. The value depends largely, of course, on the content of metallic manganese, but incidentally on the absence of such substances as phosphorus, silica, copper, cobalt, and iron. For certain purposes, other things being equal, it depends on the amount of oxygen which will be liberated under certain conditions, and this is different for the several oxidized minerals. If manganese alloys are to be produced in the blast furnace, the material should be in coherent lumps, as fine sand and powder can not be treated to advantage. On the other hand, if the material is to be used to make dry batteries or flint glass and is not already in finely divided condition it is crushed and pulverized.

The year 1917 was marked by an extraordinary increase in the price of both manganese alloys and ore and a great increase also in the number of makers of the alloys, whose competition for ores was largely the cause of the increase in price. Several new makers of alloys appeared in the field during 1918, but several withdrew, so that the number remained only slightly larger than in 1917. Although the price offered for 45 per cent Brazilian ore is reported to have risen to $1.35 per unit of manganese, or $60.75 per ton, during the first three months of 1918, there is no record that more than $1.20 per unit was offered for any grade of domestic ore adapted to making ferromanganese earlier than May 15, 1918. The Carnegie Steel Co. issued no more schedules of ore prices after that of May 2, 1917.

The winter of 1917–18 witnessed the gradual increase in power over most of the industries and the centralization of authority of the War Industries Board. In order to meet widespread complaint from ore producers concerning prices offered for ore, the board gave much attention to the manganese industry during March, April, and May, 1918, and on May 28 announced that it had approved a new schedule of ore prices adopted by the ferro alloys committee of the American Iron and Steel Institute. A copy of the announcement follows:

SCHEDULE OF MANGANESE ORE PRICES EFFECTIVE MAY 28, 1918, ADOPTED BY FERRO-ALLOYS COMMITTEE OF THE AMERICAN IRON AND STEEL INSTITUTE AND APPROVED BY THE WAR INDUSTRIES BOARD.

Schedule of domestic metallurgical manganese ore prices per unit of metallic manganese per ton of 2,240 pounds for manganese ore produced and shipped from all points in the United States west of South Chicago, Ill. This schedule does not include chemical ores as used for dry batteries, etc.

Following prices are on the basis of delivery f. o. b. cars South Chicago, and are on the basis of all-rail shipments. When shipped to other destination than Chicago, the freight rate per gross ton from shipping point to South Chicago, Ill., is to be deducted to give the price f. o. b. shipping point.

For ore containing metallic manganese when dried at 212° F.

	Price per unit.
35 per cent to 35.99 per cent	$0.86
36 per cent to 36.99 per cent	.90
37 per cent to 37.99 per cent	.94
38 per cent to 38.99 per cent	.98
39 per cent to 39.99 per cent	1.00
40 per cent to 40.99 per cent	1.02
41 per cent to 41.99 per cent	1.04
42 per cent to 42.99 per cent	1.06
43 per cent to 43.99 per cent	1.08
44 per cent to 44.99 per cent	1.10
45 per cent to 45.99 per cent	1.12
46 per cent to 46.99 per cent	1.14
47 per cent to 47.99 per cent	1.16
48 per cent to 48.99 per cent	1.18
49 per cent to 49.99 per cent	1.20
50 per cent to 50.99 per cent	1.22
51 per cent to 51.99 per cent	1.24
52 per cent to 52.99 per cent	1.26
53 per cent to 53.99 per cent	1.28
54 per cent or more	1.30

For manganese ore produced in the United States and shipped from points in the United States east of South Chicago, 15 cents per unit of metallic manganese per ton shall be added to above unit prices.

Above prices are based on ore containing not more than 8 per cent silica and not more than 0.25 per cent phosphorus, and are subject to:

Silica premiums and penalties.—For each 1 per cent of silica under 8 per cent down to and including 5 per cent, premium at rate of 50 cents per ton. Below 5 per cent silica, premium at rate of $1 per ton for each 1 per cent.

For each 1 per cent in excess of 8 per cent and up to and including 15 per cent silica, there shall be a penalty of 50 cents per ton; 15 per cent and up to and including 20 per cent silica, there shall be a penalty of 75 cents per ton.

For ore containing in excess of 20 per cent silica, a limited tonnage can be used; but for each 1 per cent of silica in excess of 20 per cent, and up to and including 25 per cent silica, there shall be a penalty of $1 per ton.

Ore containing over 25 per cent silica subject to acceptance or refusal at buyer's option, but if accepted shall be paid for at the above schedule with the penalty of $1 per ton for each extra unit of silica.

All premiums and penalties figured to fractions.

Phosphorus penalty.—For each 0.01 per cent in excess of 0.25 per cent phosphorus there shall be a penalty against unit price paid for manganese of one-half cent per unit figured to fractions.

In view of existing conditions, and for the purpose of stimulating production of domestic manganese ores, there will be no penalty for phosphorus so long as the ore shipped can be used to advantage by the buyer. The buyer reserves the right to penalize excess phosphorus as above by giving 60 days' notice to the shipper.

The above prices to be net to the producer; any expenses, such as salary or commission to buyer's agent, to be paid by the buyer.

Settlements to be based on analysis of ore sample dried at 212° F. The percentage of moisture in ore sample as taken to be deducted from the weight.

Payments.—80 per cent of the estimated value of the ore (less moisture and freight from shipping point) based on actual railroad scale weights to be payable against railroad bill lading with attached certificates of sampling and analysis of an approved independent sampling chemist. Balance on receipt of ore by buyer.

Actual railroad scale weights to govern in final settlement.

Cost of sampling and analysis to be equally divided between buyer and seller.

According to this schedule the price offered for 50 per cent ore originating west of Chicago was $61 per ton f. o. b. Chicago. If the ore originated east of Chicago the price was $68.50 per ton f. o. b. Chicago. The schedule represented a slight advance in price of most ores with less than 10 per cent of silica and was greatest for the ores originating in districts east of Chicago. As a large part of the domestic product, especially that from the Philipsburg district, Mont., and from California and Nevada contained more than 10 per cent of silica the slight reduction in price arising from the penalty for excess of silica was the cause of widespread complaint from ore producers. In defense of the silica penalties it should be stated that as long as Brazilian ore with from 3 to 6 per cent of silica was freely available a large quantity, possibly one-fourth of the total, of material with 15 to 18 per cent of silica could be smelted without causing serious losses. Under the program of restricted imports from Brazil adopted in May, however, a great increase in the per cent of domestic ore would be certain to cause extraordinary smelting losses. The schedule remained in effect until January 1, 1919, but there is no record that any ores were purchased on the basis of it after November 11, 1918.

The value of an ore adapted to use as an oxidizer in dry batteries and flint glass varies with its content of manganese dioxide, and in contradistinction to those used in metallurgical industries does not depend, except indirectly, on its content of metallic manganese. As much of the ore of the Caucasus region contains from 85 to 92 per cent of manganese dioxide and less than 1 per cent of iron and is therefore admirably adapted to these uses, most specifications for ores to be put to these uses before the war were such as could be met by ore from the Caucasus region but only rarely by ores from other regions. According to one manufacturer of dry batteries, as long as Caucasian ore was available there was little experimentation to determine the suitability of the several manganese minerals and the limits beyond which other elements than manganese may be present. As a result of recent experiments it has been shown that copper, nickel, and cobalt are the most harmful elements in the ordinary dry battery and should not be present in even minute quantities. A few tenths of 1 per cent of any of these elements renders an ore unfit for this use. On the other hand, it is stated that more than 2 or 3 per cent of iron as oxide does not necessarily greatly affect the efficiency of a battery and that the 1 per cent limit is arbitrary. In the absence of an established schedule such as exists in the steel industry, most of the ore is supplied to the dry-battery makers by brokers in lots ranging from 5 to 100 tons under guaranteed specifications. On account of the temporary elimination of Caucasian ore prices have risen, and it is reported that during 1918 prices ranged from $80 to $140 a ton. Few of the known deposits of the United States are capable of producing more than a small quantity of ore that contains less than 1 per cent iron and a trace of copper, nickel, and cobalt. During 1918 considerable ore containing no more than 70 per cent of manganese dioxide was marketed for these uses. It is estimated that the present demand for manganese ore for dry batteries and flint glass is about 35,000 tons a year.

The value of ferruginous manganese ores, manganiferous iron ores, and manganiferous silver ores depends on local conditions in the metallurgic industries that consume them, as the manganese content is used only indirectly. In both Minnesota and Colorado it is customary to pay a flat rate for ore having a certain percentage of manganese, iron, silica, moisture, and phosphorus. For each additional per cent of manganese a premium is paid, and for each additional per cent of silica or moisture a penalty is charged.

Ferruginous manganese ores containing 15 to 35 per cent of manganese, less than 15 per cent of silica, and the remainder chiefly iron were sold at the mines in 1918 at prices that ranged from $4.50 to $16 a ton.

Manganiferous zinc residuum is rarely sold in the open market but is smelted to spiegeleisen by the only company that produces it.

MANGANIFEROUS ZINC RESIDUUM.

Unique deposits of zinc ore containing franklinite, willemite, zincite, calcite, and minor silicate and other minerals occur near Franklin Furnace, N. J. By mechanical and electromagnetic processes of separation three products are obtained from these ores, one containing the greater part of the franklinite and the remaining two the other zinc minerals. The franklinite product is first roasted with anthracite to eliminate the zinc, which is recovered as zinc oxide, and the residue, containing 12 to 15 per cent of manganese and 40 per cent of iron, is smelted to spiegeleisen. The production from 1889 to 1918 is given in the following table:

Manganiferous residuum produced from zinc roasting in the United States, 1889–1918.

	Gross tons.
1889	43,648
1890	48,560
1891	38,228
1892	31,859
1893	37,512
1894	26,981
1895	43,249
1896	44,953
1897	33,924
1898	48,502
1899	65,010
1900	87,110
1901	52,311
1902	65,246
1903	73,264
1904	68,189
1905	90,289
1906	93,461
1907	93,413
1908	110,225
1909	141,264
1910	137,173
1911	109,296
1912	104,670
1913	102,239
1914	100,198
1915	159,318
1916	198,817
1917	155,332
1918	146,796
	2,551,037

NOTE.—The manufacture of spiegeleisen from manganiferous residuum was begun in 1870, but there is no record of the quantity of raw material used prior to 1889.

FERROMANGANESE AND SPIEGELEISEN.

Ferromanganese and spiegeleisen are essentially alloys of manganese, iron, and carbon, although in the ordinary processes of manufacture it is impossible to prevent the presence of small quantities of silicon and phosphorus. Their use depends upon the effects produced by the addition of small quantities of manganese and carbon to molten steel. It is commonly stated that a part of the manganese combines with any oxygen in the molten steel and the remainder increases the tensile strength of the steel and that the carbon raises the percentage of that element to the desired proportion. The name spiegeleisen (German, mirror iron) was given on account of the highly brilliant plates that develop when the alloy with 15 to 20 per cent of manganese crystallizes. It commonly contains manganese, 20 per cent; iron, 75 per cent; and carbon, 5 per cent. The ratio of manganese to carbon is therefore 4 to 1. Ferromanganese commonly contains manganese, 78 to 82 per cent; iron, 13 per cent; and carbon, 7 per cent. The ratio of manganese to carbon is therefore about 12 to 1. There appears to be no natural division between the manganese contents of spiegeleisen and ferromanganese, but 40 per cent is commonly accepted by the steel trade.

Spiegeleisen was the first alloy to be developed, and it was added to all steel made by the Bessemer and open-hearth processes until about 1875, when ferromanganese became a commercial product. For many years thereafter spiegeleisen was used only in making so-called "medium" and "high-carbon" steels (those containing more than 0.25 per cent carbon) by the Bessemer process, whereas ferromanganese was used in making "low-carbon" steel (that containing less than 0.25 per cent carbon). It can readily be understood that for a given quantity of manganese in the form of alloys added to the molten steel three times as much carbon is added if spiegeleisen is used than if ferromanganese is used. During recent years, even before the outbreak of war in 1914, many steel makers have experimented with the use of alloys in which the manganese content ranged between that in spiegeleisen and that in ferromanganese, as well as other alloys, such as silicomanganese. The use of several of the alloys for special purposes has been fairly established, and, although a few steel makers have contended that in spite of the low ratio of manganese to carbon, alloys with 15 to 35 per cent of manganese could be used to make steel with 0.10 to 0.25 per cent of carbon, the practice has not come into wide use.

During 1918 the domestic production of ferromanganese was 306,076 tons, the largest recorded, and imports were 27,168 tons, the smallest since 1904. As a result of the recommendations in April of the American Iron and Steel Institute to its members the grade of most of the ferromanganese made in the United States during 1918 was reduced from 80 to 70 per cent of manganese and of spiegeleisen from 20 to 16 per cent of manganese. Some makers made large quantities of ferromanganese containing 60 to 65 per cent of manganese. The imported material contained about 80 per cent of manganese.

The firms that made ferromanganese and spiegeleisen during 1918 are listed below (f indicates ferromanganese; s, spiegeleisen):

fs__American Manganese Manufacturing Co., Dunbar, Pa.
f___Anaconda Copper Mining Co., Great Falls, Mont.
f___B. & B. Trading Co., Troy, N. Y.
fs__Bethlehem Steel Corporation, Lebanon, Pa.
f___Bilrowe Alloys Co., Tacoma, Wash.
s___Colorado Fuel & Iron Co., Pueblo, Colo.
f___Donner Steel Co., North Tonawanda, N. Y.
fs__J. B. Guernsey & Co., Graham, W. Va.
s___J. B. Guernsey & Co., Roanoke, Va.
f___Iron Mountain Alloys Co., Utah Junction, Colo.
fs__Juniata Furnace & Foundry Co., Newport, Pa.
f___Lavino Furnace Co., Lebanon, Pa.
fs__Lavino Furnace Co., Marietta, Pa., and Reusens, Va.
s___Lavino Furnace Co., Sheridan, Pa.
f___E. E. Marshall, Harrisburg, Pa.
fs__Miami Metals Co., South Chicago, Ill.
fs__Midvale Steel & Ordnance Co., Johnstown, Pa.
s___New Jersey Zinc Co., Palmerton, N. J.
f___Noble Electric Steel Co., Heroult, Calif.
f___Pacific Electro Metals Co., Bay Point, Calif.
fs__Seaboard Steel & Manganese Corporation, Temple, Pa.
f___Seattle Smelting Co., Seattle, Wash.
fs__Southeastern Iron Corporation, Goshen, Va.
fs__Southern Manganese Corporation, Anniston, Ala.
fs__Tennessee Coal, Iron & Railroad Co., Bessemer and Birmingham, Ala.
fs__United States Steel Corporation, Chicago, Ill., and Pittsburgh, Pa.
f___Western Reduction Co., Portland, Oreg.
f___Wharton Steel Co., Wharton, N. J.

Ferromanganese and spiegeleisen produced[a] in the United States, 1901–1918.

Year.	Ferromanganese.		Spiegeleisen.	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
1901	59,639	(b)	231,822	(b)
1902	44,526	(b)	168,408	(b)
1903	35,961	(b)	156,700	(b)
1904	57,076	(b)	162,370	(b)
1905	62,186	(b)	227,797	(b)
1906	55,520	(b)	244,980	(b)
1907	55,918	(b)	283,430	(b)
1908	40,642	(b)	111,376	(b)
1909	82,209	(b)	142,831	(b)
1910	71,376	(b)	153,055	(b)
1911	74,602	[c]$4,746,541	104,013	(c)
1912	125,378	[c]8,282,006	102,561	(c)
1913	119,495	[c]9,272,269	106,980	(c)
1914	100,731	4,440,253	76,625	$1,586,139
1915	144,260	9,253,443	114,556	2,402,550
1916	224,103	30,123,493	182,837	6,158,202
1917	260,225	53,930,771	189,241	9,756,236
1918	306,076	69,045,678	263,861	17,276,494

[a] Beginning with 1911 the figures represent product marketed (or shipped).
[b] Figures not available.
[c] Value for spiegeleisen included with that for ferromanganese.

Ferromanganese and spiegeleisen imported for consumption in the United States, 1903–1918.

Year.	Ferromanganese.		Spiegeleisen.		Total.	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
1903	41,519	$1,699,666	122,015	$2,709,317	163,534	$4,408,983
1904	21,813	707,037	4,623	132,461	26,436	839,498
1905	52,841	1,884,651	55,457	1,336,104	108,298	3,220,755
1906	84,359	4,953,644	103,268	2,942,940	187,627	7,896,584
1907	87,400	5,354,656	48,994	1,399,381	136,394	6,754,037
1908	44,624	1,860,664	4,579	125,054	49,203	1,985,718
1909	88,934	3,396,381	16,921	356,447	105,855	3,752,828
1910	114,228	4,341,071	25,383	489,049	139,611	4,830,120
1911	80,263	3,015,062	20,970	405,444	101,233	3,420,506
1912	99,137	3,906,920	1,015	28,094	100,152	3,935,014
1913	128,070	5,682,915	77	2,173	128,147	5,685,088
1914	82,997	3,619,607	2,870	71,147	85,867	3,690,754
1915	55,263	3,333,699	200	5,110	55,463	3,338,809
1916	90,928	9,240,528	....	....	90,928	9,240,528
1917	41,969	5,710,988	3,968	291,594	45,937	6,002,582
1918	27,168	4,258,745	1,969	228,012	29,137	4,486,757
	1,141,513	62,966,234	412,309	10,522,327	1,553,822	73,488,561

Although the contract price of ferromanganese was not definitely fixed by the War Industries Board, the agreement of that board with the American Iron and Steel Institute, dated May 28, 1918, concerning the prices to be paid for ores led to the establishment of prices for both ferromanganese and spiegeleisen which were maintained to the end of the year. Before April 1 the price of 80 per cent ferromanganese was about $250 a ton, but soon after that date the same price was asked for 70 per cent alloy, with an added charge of $4 per unit for each additional per cent of manganese, so that 80 per cent alloy was held at $290 a ton. The price of 20 per cent

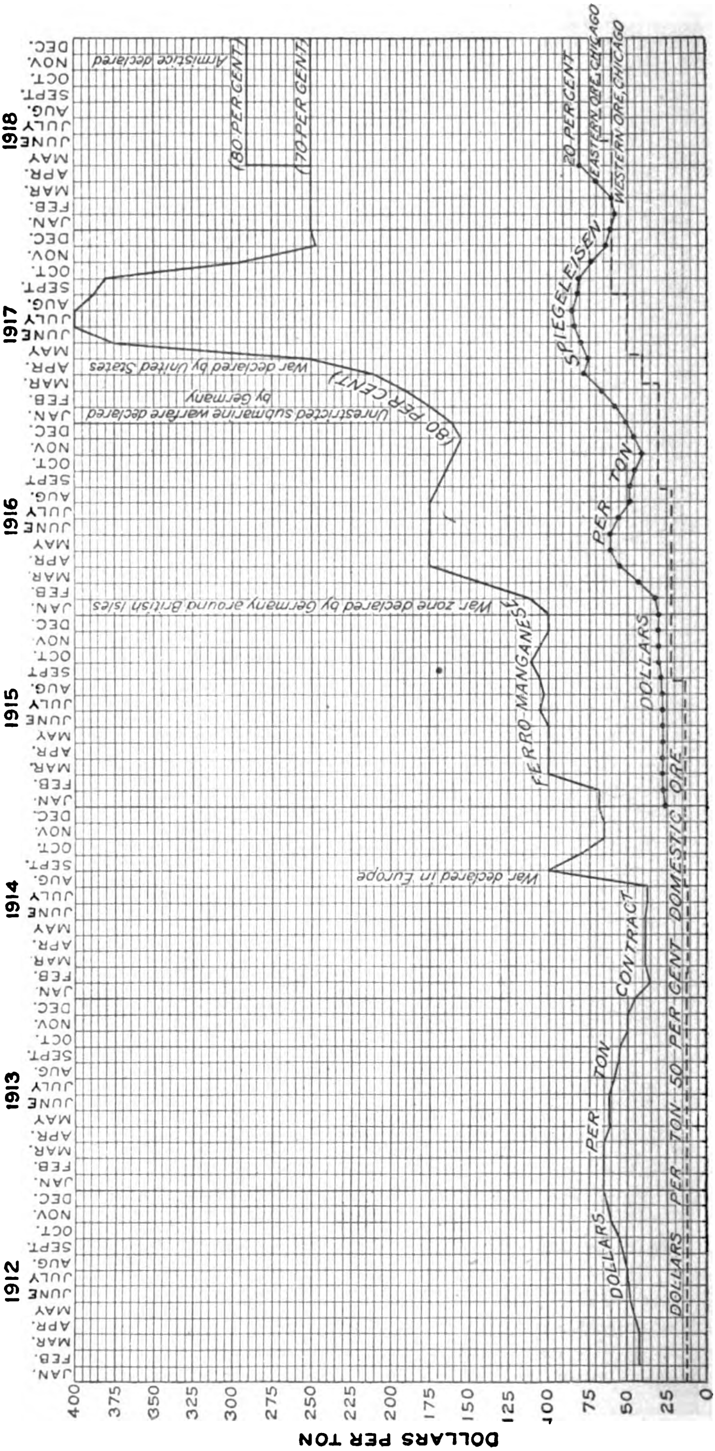

FIGURE 10.—Diagram showing contract prices of ferromanganese, spiegeleisen, and manganese ore, 1912–1918.

spiegeleisen rose from $62 in January to $80 in April and this price was maintained throughout the remainder of the year.

The accompanying diagram (fig. 10) shows the prices of 50 per cent manganese ore and of ferromanganese from 1912 to 1918, inclusive, and of spiegeleisen from 1915 to 1918.

As more than 95 per cent of the manganese ore required for the country is converted to manganese alloy for use in the steel industry, a correct impression of the extent to which domestic ores contributed to recent requirements may be obtained by determining the quantity of metallic manganese in the form of alloys which was derived from domestic ores. The makers of manganese alloys report annually to the Geological Survey the quantities of manganese and manganiferous ores that are used in making the annual output of alloys. They also report the source and grade of the material.

The following table presents calculations made from these data which aim to determine the proportion of manganese in the combined imported and domestic alloys that has been derived from domestic materials. According to the table, the percentage of metallic manganese in the available supply of ferromanganese that was derived from domestic ores increased from 0.4 per cent in 1913 to 23.6 per cent in 1918. Further, the percentage of metallic manganese in the available supply of spiegeleisen derived from domestic materials increased from 38.5 per cent in 1913 to 93.8 per cent in 1915 and then declined to 86 per cent in 1918. Finally, the percentage of metallic manganese in the available supply of both alloys derived from domestic materials increased from 4.1 per cent in 1913 to 35.2 per cent in 1918. Thus, it may be concluded that under the stress of war, contrary to the expectations of many well-informed persons, the contribution of manganese from domestic ores increased from an insignificant part in 1913 to about one-third of the total in 1918. These data considered with the information concerning domestic deposits of manganese available during the last few months of 1918 indicate that if the war had continued through 1918 about one-half of the manganese needed by the steel industry would have been derived from domestic materials.

In any attempt to determine whether the rate of production of Bessemer and open-hearth steel in 1918 (43,835,627 tons) could be maintained largely or wholly from the product of domestic deposits of manganese, many metallurgic as well as geologic data should be considered. The table shows clearly that, although the grades of steel produced between 1913 and 1918 probably did not greatly change, the percentage of the total metallic manganese made and apparently used as spiegeleisen in that period rose steadily from 9.6 to 18.3 per cent. As an abundant supply of low-grade manganese ores is available from domestic sources, a much larger demand for the alloy could have been readily met. The conclusion may be tentatively stated, however, that only under most extraordinary conditions of control and coordination of the related industries could the output of steel in 1918 have been made from manganese and manganiferous ores of domestic origin alone.

Manganese alloys imported and percentage made from domestic and imported ores in the United States, 1913–1918, in gross tons.

	1913		1914		1915		1916		1917		1918	
	Alloy.	Manganese.	Alloy.	Manganese.	Alloy.	Manganese.	Alloy.	Manganese.	Alloy.	Manganese.	Alloy.	Manganese.
Ferromanganese:												
Imported	128,070	102,456	82,997	66,398	55,263	42,210	90,928	72,742	41,969	33,575	27,168	21,733
Domestic production [a]	119,495	94,342	100,731	79,408	145,842	113,378	227,801	171,051	260,270	193,079	318,948	220,771
From domestic ore	[b]1,075	[b]850	[b]1,978	[b]1,408	[b]1,946	[b]1,568	[b]17,172	[b]12,845	[b]29,813	[b]23,152	[b]80,308	[b]57,324
From imported ore	[b]118,420	[b]93,492	[b]98,753	[b]78,000	[b]143,896	[b]111,810	[b]210,629	[b]158,206	[b]230,457	[b]169,927	[b]238,640	[b]163,447
Total	247,565	196,798	183,728	145,806	201,105	155,588	318,729	243,793	302,239	226,654	346,116	242,504
Percentage of manganese as ferromanganese made from domestic ore		0.4		0.9		1.0		5.3		10.2		23.6
Number of plants making ferromanganese	2		5		9		13		22		27	
Spiegeleisen:												
Imported	77	15	2,870	574	200	40			3,968	793	1,969	394
Domestic production [a]	106,980	20,845	76,625	15,732	114,446	23,638	184,822	40,151	199,024	44,323	273,952	54,405
From domestic ore	41,744	8,020	51,511	10,707	107,062	22,218	141,795	31,538	170,914	38,419	232,986	47,103
From imported ore	65,236	12,825	25,114	5,025	7,384	1,420	43,027	8,613	28,110	5,904	40,966	7,302
Total	107,057	20,860	79,495	16,306	114,646	23,678	184,822	40,151	202,992	45,116	275,921	54,799
Percentage of manganese as spiegeleisen made from domestic ore		38.5		66.3		93.8		78.5		85.1		86.0
Number of plants making spiegeleisen	4		6		7		11		17		18	
Total available supply of metallic manganese as alloys		217,658		162,112		179,266		283,944		271,770		297,303
Percentage of total manganese imported as alloys		47.1		41.3		23.6		25.6		12.7		7.3
Percentage of total manganese as ferromanganese made in the United States from imported ore		42.9		48.1		62.3		55.7		62.5		55.0
Percentage of total manganese as spiegeleisen made in the United States from imported ore		5.9		3.1		0.8		3.1		2.2		2.5
Percentage of total manganese as ferromanganese made in the United States from domestic ore		.4		.9		.9		4.5		8.5		19.3
Percentage of total manganese as spiegeleisen made in the United States from domestic ore		3.7		6.6		12.4		11.1		14.1		15.9
Percentage of total manganese as alloys made from domestic ore		4.1		7.5		13.2		15.6		22.7		35.2
Percentage of total manganese made and imported as spiegeleisen		9.6		10.0		13.2		14.1		16.6		18.3
Total open-hearth and Bessemer steel		31,145,637		23,395,530		31,966,315		42,474,466		44,628,853		43,835,627

[a] Quantity made.

[b] Partly estimated.

The data of this table permit also the calculation of the apparent trend of consumption of manganese in the form of alloys. If the total manganese contained in the alloys produced and imported during 1913 and 1914 is converted to pounds and divided by the production of open-hearth and Bessemer steel during those years, it will be found that 15.6 pounds of metallic manganese was produced and imported per ton of steel made. Inequalities of stocks between the beginning and end of the year are partly offset by considering the biennial period instead of the single year. If the same calculation is made for the biennial periods 1915–16 and 1917–18, it will be found that the combined production and imports of manganese in the form of alloys was 14 and 14.3, respectively, per ton of steel produced. The conclusion that nearly 10 per cent less manganese was used in making steel during the war period, when prices of alloys were high, than before the war appears to be well justified.

MANGANESE DEPOSITS OF THE UNITED STATES.

In 1910 Harder prepared a map[1] showing the distribution of domestic manganese deposits. On this map there were shown the locations of 96 areas within which manganese deposits were recorded. The search for domestic manganese during 1916, 1917, and 1918 has brought to light so many deposits that were not known in 1909 that it has seemed advisable to prepare the new map which is included with this report. This map (Pl. V) has been prepared by J. H. Winchell under the supervision of E. C. Harder and the writer.

On the map prepared in 1909 five classes of areas were shown, as follows: (1) Areas of pre-Cambrian and later metamorphic rocks containing concentration deposits of manganese and manganiferous ore or bodies of silicates; (2) areas of Paleozoic rocks containing bedded and concentration deposits of manganese and manganiferous ore; (3) areas containing western manganiferous silver-ore deposits; (4) areas of the Franciscan formation containing jasper lenses with manganese ore; and (5) areas of both igneous and sedimentary rocks containing veins, contact, bog, and miscellaneous deposits of manganese and manganiferous ore.

Although deposits of most minerals may be classified in several ways, and each way may possess peculiar merit, there is not a great range in choice of the basis of classification of deposits on a map. Most economic geologists and engineers are interested in systems of classification based on mode of origin, but many other persons can not readily use such information, and in the present case sufficient data are not available to permit the satisfactory classification of many important deposits. Hence the principal basis of classification that has been adopted for the maps of the manganese deposits of the United States is the form of the deposit, although dominant minerals are also used and mode of origin is partly indicated. The classification follows:

1. Stratiform masses:
    - (*a*) Oxides interlayered with sediments or layered volcanic or metamorphic rocks.
    - (*b*) Carbonates or silicates interlayered with sediments or layered volcanic or metamorphic rocks.
    - (*c*) Oxides, as surface bog deposits.

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[1] Harder, E. C., Manganese deposits of the United States: U. S. Geol. Survey Bull. 427, pl. 1, 1910.

2. Veins and breccia fillings:
    (*a*) Oxides in larger part.
    (*b*) Carbonates or silicates partly weathered to oxides.
3. Irregular masses:
    (*a*) Oxides.
    (*b*) Carbonates or silicates largely weathered to oxides.
4. Aggregates of small bodies in clay or weathered rocks:
    (*a*) Mainly oxides.
5. Unclassified deposits:

MANGANESE DEPOSITS, BY STATES.

ALABAMA.

The Southern Manganese Corporation exploited two deposits of high-grade ore in the Altoona district, Blount and Etowah counties, Ala. Low-grade ore was shipped from Calhoun, Clay, and Talladega counties.

ARIZONA.

Although the number of shippers of high-grade ore in Arizona increased from 22 in 1917 to 35 in 1918, the shipments in 1918 were only 20 per cent larger than in 1917. Of the 17,612 tons shipped in 1918, 12,835 tons were derived from deposits in the Bisbee district. Most of the remainder came from deposits in the Tombstone district, Cochise County, and from Maricopa, Pinal, Santa Cruz, and Yuma counties.

Allen and Butler[1] summarize the distribution of manganese deposits in the State. Jones[2] describes several deposits in Mohave and Yuma counties; most of the deposits are very inaccessible, and no material was shipped from them in 1918.

ARKANSAS.

Although the number of shippers of high-grade ore from the Batesville district of Arkansas in 1918 was nearly twice that in 1917, the shipments were actually less than in 1917. The principal cause of the decline was the temporary cessation of work at many properties in order to install additional equipment in the hope of greatly increasing the rate of shipment of ore. At the time the armistice was signed many properties were ready for greatly enlarged operations.

Most of the output came from the Batesville district, Independence and Izard counties, but there were small shipments from Polk and Sharp counties.

CALIFORNIA.

The number of shippers of ore in California in 1918 was only slightly larger than in 1917, but the quantity of material shipped in 1918 was twice as large. Shipments from the Ladd mine, San Joaquin County, were less than in 1917, but those from the Buckeye mine, San Joaquin County; Welch mine, San Luis Obispo County;

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[1] Allen, M. A., and Butler, G. M., Manganese: Arizona Bur. Mines Bull. 91, p. 32, 1918.
[2] Jones, E. L., jr., Manganese deposits in the Colorado River desert region of Arizona, California, and Nevada; U. S. Geol. Survey press bulletin, 1919.

and many other smaller mines were much larger. Ore was shipped by 47 shippers from 57 localities in 16 counties.

Representatives of the State Mining Bureau[1] and the California Council of Defense examined most of the deposits of the State during 1917 and 1918. Jones[2] examined deposits in Imperial and Riverside counties in June, 1918.

COLORADO.

Except for exploration at several new deposits in Fremont, Gunnison, Saguache, and Teller counties, there was little change in the industry in Colorado. A larger quantity of material was shipped from Leadville to eastern smelters than in 1917, and in order to offset the high freight rates the attempt was made to ship only material with 28 to 35 per cent of manganese. Shipments from the district decreased greatly during the last six months on account of the great increase in stocks at most of the furnaces.

GEORGIA.

About 80 per cent of the shipments during 1918 came from deposits in the Cartersville district, Bartow County, Ga. The remainder was shipped from deposits in Fannin, Floyd, Lincoln, and Whitfield counties, most of which had not previously been exploited.

The manganese deposits of the State were examined by a geologist of the United States Geological Survey in cooperation with a geologist of the Georgia Geological Survey and an engineer of the United States Bureau of Mines.[3]

MICHIGAN.

All the low-grade ore shipped in Michigan in 1918 was derived from the Bengal mine, Iron County.

MINNESOTA.

The action of the American Iron and Steel Institute in April, 1918, by which it urged its members to reduce the grade of ferromanganese from 80 to 70 per cent of manganese, created a large market for Cuyuna Range ores, and consequently shipments in 1918 were about twice those in 1917. Four more mines entered the list of shippers in 1918.

A summary of an exhaustive investigation of the possible ways of treating and utilizing Cuyuna Range ores was published during the year.[4]

MONTANA.

Of the extraordinary increase in shipments from Montana mines during 1918 about one-half was derived from deposits in the Philipsburg district and one-half from those in the Butte district. The

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[1] Bradley, W. W., and others, Manganese and chromium: California State Min. Bur. Bull. 76, pp. 9–100, 1918.

[2] Jones, E. L., jr., op. cit.

[3] Hull, J. P. D., La Forge, L., and Crane, W. R., Manganese deposits of Georgia: Georgia Geol. Survey Bull. 35, 295 pp., 1919.

[4] Newton, E., Manganiferous iron ore of the Cuyuna district, Minn.; Minnesota School of Mines Exper. Sta. Bull. 5, 126 pp., 1918.

Emma mine was the source of most of the shipments from the Butte district.

During the year the Philipsburg Mining Co. completed a modern mill especially designed to treat the oxidized manganese ores at Philipsburg. The Ophir mill of the Butte Central Mining & Milling Co., at Butte, and the mill of the New York-Montana Testing & Engineering Co., at Helena, concentrated large quantities of oxide ores to a marketable product. The first mill also made experiments in the concentration of siliceous carbonate ores.

NEVADA.

Although the number of shippers in Nevada in 1918 was much larger than in 1917, the great increase in shipments from the State was largely derived from one mine, the Three Kids, near Las Vegas, Clark County.[1]

The deposits in White Pine County were examined by J. T. Pardee[2] in June, 1918.

NEW JERSEY.

Deposits near Annandale, Hunterdon County, were the source of several carloads of ore during the year.

NEW MEXICO.

As in 1917, the Lake Valley mine was the source of a large part of the shipments of high-grade ore from New Mexico in 1918. The production of low-grade ore from the Silver City deposits steadily increased during 1918 to the maximum that has been recorded, and 32,832 tons were shipped during the year.

The manganese deposits of the State are described by Wells[3] and Jones.[4]

NORTH CAROLINA.

The Tar Heel mine, near Mount Airy, Surry County, was the source of most of the shipments from North Carolina in 1918.

OREGON.

Several new deposits on Lake Creek, above Eagle Point, Jackson County, Oreg., were actively explored during 1918, but that owned by the Manganese Metal Co., of Tacoma, was the source of all of the shipments. The deposits were examined by Pardee[5] in July.

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[1] Hale, F. A., jr., Manganese deposits in Clark County, Nev.: Eng. and Min. Jour., vol. 105, pp. 775–777, 1918. Jones, E. L., jr., op. cit.

[2] Pardee, J. T., Manganese deposits in White Pine County, Nev.: U. S. Geol. Survey Press Bull. 374, 1918.

[3] Wells, E. H., Manganese in New Mexico; New Mexico State School of Mines Bull. 2, pp. 1–85, 1918.

[4] Jones, E. L., jr., Some manganese deposits in New Mexico (preliminary report): U. S. Geol. Survey press bulletin, 1918.

[5] Pardee, J. T., Manganiferous ores in the Lake Creek district, Jackson County, Oreg.: U. S. Geol. Survey Press Bull. 383, 1918.

SOUTH CAROLINA.

The Atlantic Manganese Co. made several shipments from the deposits near McCormick, Abbeville County, S. C., but abandoned work early in the spring.

SOUTH DAKOTA.

Deposits near Lead, Lawrence County, S. Dak., were the source of one shipment of ore.

TENNESSEE.

Manganese deposits have been known in several parts of Tennessee for many years, but interest in the ore during 1917 and 1918 led to the discovery of many new deposits. Deposits were explored in 10 counties—Blount, Bradley, Carter, Cocke, Grainger, Johnson, Loudon, Monroe, Unicoi, and Washington—but those of Johnson County were the source of most of the shipments.

All the recorded deposits were examined by G. W. Stose and F. C. Schrader, of the United States Geological Survey, in cooperation with the Tennessee Geological Survey.[1]

TEXAS.

All the shipments in Texas in 1918 were derived from the Spiller mine in Mason County. Other deposits in Val Verde County were explored.

UTAH.

As in 1917, the well-known deposits of Grand County[1] shipped most of the output of the State during 1918. Deposits in Juab and Tooele[2] counties were also the source of regular shipments.

VIRGINIA.

Although the number of shippers of high-grade ore in Virginia in 1918 was larger than in 1917, the quantity of ore shipped was actually less. The decrease was due to several causes. A number of mines that shipped regularly during 1917 devoted much time in 1918 to the installation of additional equipment in the hope of greatly increasing their shipments, but were hindered by inabilty to market their product during the last three months of the year. The output of several mines in Bland, Rockbridge, and Rockingham counties in 1918 was much less than in 1917 on account of the exhaustion of easily accessible material of desirable grade. High-grade ore was shipped from mines in Augusta, Bland, Campbell, Craig, Frederick, Giles, Nelson, Page, Russell, Shenandoah, Smyth, and Warren counties.

A comprehensive report on the manganese deposits in the Blue Ridge belt, based on work during 1917 by geologists of the United

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[1] Stose, G. W., and Schrader, F. C., Manganese deposits of East Tennessee: Resources of Tennessee, vol. 8, pp. 153–207, 231–324, Tennessee Geol. Survey, 1918.

[2] Pardee, J. T., Manganese in the Green River district, Utah: U. S. Geol. Survey Press Bull. 384, 1918.

[2] Pardee, J. T., Manganese ore in the Tintic district, Utah: U. S. Geol. Survey Press Bull. 379, 1918.

States Geological Survey in cooperation with the Virginia Geological Survey, was published in 1919.[1]

WASHINGTON.

The deposits in Washington on the east slope of the Olympic Mountains, west of Hoodsport and Quilcene,[2] were explored during the year, but no shipments were reported.

WYOMING.

The Poverty Mine in Albany County, Wyo., was the source of the entire output of the State in 1918.[3]

FOREIGN MANGANESE DEPOSITS.

BRAZIL.

Vice Consul R. P. Momsen reports[4] that the dividends declared by the company operating the principal manganese mine in Brazil (Morro da Mina?) during the last four years have been as follows: 1914, $210,000; 1915, $1,320,000; 1916, $2,100,000; and 1917, $1,980,000. Mr. Momsen also reports[5] that a recent article in the Monitor Mercantile of Rio de Janeiro describes the important mining operations recently commenced in the State of Bahia. These include the exploitation of manganese deposits in the Bomfim and Campo Formosa districts.

Consul E. Higgins in reporting the imports and exports from the State of Bahia during 1916 and 1917 states:[6]

> During the war manganese was mined by three companies. One of these companies, which controls several deposits in the interior and one mine on the seacoast, introduced machinery and intends to compete on a peace basis. Mining in the interior has been discontinued because of the inability of the railroad to handle the output, as 40,500 tons are now awaiting transportation. The deposit on the coast is being worked to its full capacity, however.

No manganese ore was exported from Bahia in 1916, but 29,388 tons (metric?), valued at $473,530, was exported during 1917.

Vice Consul R. P. Momsen reports[7] the average price of manganese ore in Brazil, as follows: 1914, 22 milreis ($5.72) a ton; 1915, 29 milreis ($7.54) a ton; 1916, 55 milreis ($14.30) a ton; 1917, 93 milreis ($24.28) a ton; and for the first six months of 1918, 117 milreis ($30.42) a ton.

Consul G. H. Pickerell, of Para, presents[8] the summary of a report on manganese deposits in the municipality of Turyassú, on the north coast of Brazil, 190 miles west of Para. The deposits lie within a tract of 20,000 acres and the best outcrop of ore is 4½ miles from the harbor of São José, on Piracaua River. Lighters of

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[1] Stose, G. W., Miser, H. D., Katz, F. J., and Hewett, D. F., Manganese deposits of the west foot of the Blue Ridge, Virginia: Virginia Geol. Survey Bull. 17. 166 pp., 1919.

[2] Pardee, J. T., Manganese deposits in the Olympic region, Wash. (preliminary report): U. S. Geol. Survey press bulletin, 1918.

[3] Jones, E. L., jr., Manganese ore in Wyoming (preliminary report): U. S. Geol. Survey press bulletin, 1918.

[4] Daily Cons. and Trade Repts., March, 1918.

[5] Idem, June 18, 1918.

[6] Idem, May 23, 1918.

[7] Idem, Nov. 12, 1918.

[8] Idem, Feb. 8, 1918.

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300-tons capacity may approach within 1 mile of the deposit by following a branch of another river. The deposits have been explored by trenches only, but it is reported that they resemble those of the Lafayette district in Minas Geraes. Manganese oxides appear to form distinct lodes that range from 1.25 meters (4.1 feet) to 2.70 meters (8.8 feet) in width and may be traced for about 1,000 meters (3,280 feet). It is estimated that one hill contains about 300,000 tons of ore, carrying more than 48 per cent of manganese within 50 feet of the surface. Samples show manganese, 47.9 to 51.2 per cent; iron, 6.5 to 9.3 per cent; silica, 4 to 5.1 per cent; and phosphorus, 0.04 to 0.20 per cent. Other deposits are known, but have not been explored.

The report of the San Juan del Rey and Ouro Preto gold mines for August, 1917, records[1] the recent discovery of a large belt of manganese oxides in the company's property in the State of Minas Geraes.

CANADA.

Several manganese deposits were discovered near Kaslo, British Columbia, in July, 1917, and explored in 1918.[2] The deposits that have been explored are found on three terraces which extend along the east side of the valley of Kaslo Creek. Manganese oxides in the form of wad, containing about 40 per cent of manganese, occur as horizontal layers from several inches to 3 feet in thickness, underlain by boulder clay and overlain by calcareous tufa. Manganese oxides also cement adjacent surface débris. The largest deposit contains a bed of wad that ranges from a few inches to 2½ feet in thickness over an area 600 feet long and 200 feet wide. An analysis of the first car of ore that was shipped is reported to have shown manganese, 39.65 per cent; iron, 4.40 per cent; silica, 10.98 per cent; phosphorus, 0.0074 per cent. It is estimated that the known deposits will not yield more than several hundred tons of material carrying more than 40 per cent of manganese.

G. C. Mackenzie[3] describes a manganese deposit recently discovered near Lake Cowichan, at the summit of the divide between Chemainus and Cowichan rivers, Vancouver Island. Manganese oxides, manganite and psilomelane, form an outcrop 12 feet wide and about 100 feet long in a group of quartzite rocks known as the Sicker series. The deposits have not been explored, but the presence of rhodonite on both sides of the outcrop of oxides indicates that they have been derived from that mineral and that it probably underlies the oxides near the surface.

The report of W. L. Uglow[4] describes deposits of manganese oxides 11 miles south of Moncton, Albert County, New Brunswick. The two deposits that are known range from a few inches to 15 feet and average 3 feet in thickness over an area of 12½ acres. The oxides are deposited on a porous mass of wet peat, which when freshly dug contains water, 65 to 73 per cent; peat and impurities, 17 to 20 per cent; manganese, about 7 per cent; and iron, 3 to 7 per cent. It is estimated that the total quantity of manganese (metal?) in the two bogs is 2,975 tons. Several attempts to exploit the deposits have been made since 1887, but none was successful.

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[1] Abstracted in Eng. and Min. Jour., vol. 106, p. 371, 1918.

[2] Bancroft, M. F., Investigations in the Slocan district, British Columbia: Canada Geol. Survey Summary Rept., 1917, pt. B, pp. 29–33, 1918.

[3] Mackenzie, G. C., An investigation of certain Canadian platinum and manganese resources: Canadian Min. Inst. Bull. 84, pp. 432–434, 1919.

[4] Abstract in New Brunswick Crown Land Dept. Fifty-eighth Ann. Rept., pp. 16, 17, 1918.

COSTA RICA.

According to Consul B. F. Chase,[1] manganese mining developed rapidly in Costa Rica in 1916 and 1917, and the industry now employs from 300 to 400 men. The exports were 1,305 (long?) tons in 1916 and 5,727 tons in 1917.

CUBA.

On the basis of examinations made during February, March, and April, 1918, E. F. Burchard[2] has described the manganese deposits of Cuba.

All the recorded deposits in the Provinces of Oriente, Matanzas, Pinar del Rio, and Santa Clara were examined by Burchard except two, which were examined by G. S. Rogers and M. Roesler.

The following general classes of deposits were recognized: "(*a*) Deposits in bedded rocks; (*b*) deposits in irregular masses associated with siliceous rock, such as jasper or 'bayate,' and (*c*) deposits of nodules and fragments in residual clay." It is estimated that there are 700,000 to 800,000 tons of material carrying more than 36 per cent of manganese in the deposits examined, most of which are in the Santiago district.

In a preliminary review of the Cuban manganese industry during 1918, J. B. Stewart[3] estimates that the shipments were 95,000 tons compared with 35,000 tons in 1917. By addition of concentrating plants, 75 per cent of the total output of manganese ore was washed or concentrated.

The prospect for maintaining operations at most of the Cuban mines after the close of the war appears to depend on either effective cooperation of the owners and lessees or the purchase of the most promising deposits by a small group of owners.

ECUADOR.

Consul General F. W. Goding, of Guayaquil, reports[4] that manganese deposits near San Antonio, Province of Pichincha, 28 miles from Quito, were exploited during 1918. The principal deposit appears to be a bedded vein of oxides that ranges from 3 to 9 feet thick over an area of about half an acre. An analysis of an average sample showed manganese, 46.36 per cent; iron, 1.55 per cent; copper, 0.02 per cent; phosphorus, 0.14 per cent; and silica, 6.40 per cent. The deposit lies at an elevation of 7,874 feet and conditions favor cheap operation.

MEXICO.

Consul J. B. Stewart reports[5] that there is much prospecting of manganese deposits in the vicinity of Chihuahua and that recently about 350 tons of material carrying 40 to 48 per cent of manganese have been exported to the United States. The deposits are found in the suburbs of the city of Chihuahua, as far as Ortiz, southeast of Chihuahua, and westward along the Northwest Railroad of Mexico.

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[1] Daily Cons. and Trade Repts., Nov. 10, 1918.

[2] Burchard, E. F., Manganese ore deposits in Cuba: Am. Inst. Min. and Met. Eng. Trans., preliminary pamphlet, 52 pp., 1919.

[3] Stewart, J. B., Cuban manganese in 1918: Eng. and Min. Jour., vol. 107, p. 196, 1919.

[4] Letter to Department of State, Dec. 19, 1918.

[5] Daily Cons. and Trade Repts., Oct. 26, 1918.

Leonard Worcester, of El Paso, Tex., states[1] that he is mining manganese ore 4 miles north of Chihuahua, 15 miles south of Palomas, and 45 miles southwest of Chihuahua.

Avila & Rosado, of Mexico City, state[2] that they are exploiting manganese deposits in a mountainous region 18 miles from Leon, State of Guanajuato.

By presidential decree, effective April 28, 1918, a duty of 3 per cent of the value on New York markets was placed on exports of manganese ore.[3]

PANAMA.

Consul J. D. Dreher reports[4] that the American Co., which has exploited manganese deposits near Mandinga since 1916, has recently obtained a concession to mine manganese ore from deposits on Boqueron River 12 or 25 miles south of Porto Bello and will attempt to mine and ship the material.

RUMANIA.

V. C. Butureanu describes[5] the manganese minerals of the region near Brosteni, northwestern Moldavia, and briefly mentions their geological associations. The group name "ponites" is given to manganese carbonates containing several per cent of ferrous oxide which form veins in schists and other crystalline rocks in the region. The group name "brostenite" is given to compact hydrous oxides of manganese and iron which are associated with the carbonates. The deposits have not been extensively explored, but the author estimates that 30,000,000 tons of the minerals which would yield 10,000,000 ton of ferromanganese are available in them.

URUGUAY.

Pockets and traces of manganese are found in practically all parts of Uruguay. Numerous small and some larger deposits of ore have been examined or are known to the Bureau of Geology, and drillings are mentioned in a report on the mineral resources of the country published in 1916.

Most of the deposits are too small or too poor in quality to make exploitation worth while. In other cases lack of transportation facilities and timber stand in the way of successful operation.

One of the principal deposits is found in the Department of Rivera near the Arroyo Zapucay. There are two hills made up almost entirely of ore, and it is estimated that 80,000,000 tons could be taken out by open cuts. The deposit is covered by nine concessions extending over 22,000 acres and is the property of the Uruguay Manganese Co. The analysis shows an average content of 34.8 per cent of iron; 22.7 per cent of manganese; 9 per cent of silica; 0.03 per cent of phosphorus, and 0.05 per cent of sulphur. The Uruguay Manganese Co. was formed at Montevideo several years ago, the stock being subscribed largely by English investors. It was planned to build a 75-mile branch of the Central Uruguay Railroad to the deposit and the venture aroused much interest. Very little development work has been done, however, and the deposit is not being worked. There are at present no transportation facilities and the necessary fuel and timber for such a ferromanganese proposition are lacking.

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[1] Letter to U. S. Geol. Survey, June 1. 1918.

[2] Oral communication to U. S. Geol. Survey.

[3] Daily Cons. and Trade Repts., Mar. 4, 1918.

[4] Idem, July 20, 1918.

[5] Butureanu, V. C., The ores of manganese and iron of the crystalline massif of Brostent, Rumania: Soc. franc. min. Bull., vol. 40, pp. 164–177, 1917.

The same difficulties stand in the way of working a similar ferromanganese (?) deposit at Caraguata, in the Department of Tacuarembo.

There are a number of small deposits of manganese in other departments and, as stated above, pockets and traces of the ore occur practically all over the country.

One of these is located at Carrasco, some 9 miles east of Montevideo on the coast. It has been examined by representatives of British and German interests and is being worked at present on a small scale, the ore being used by glass factories. The outcrops are small and scattered, and the deposit appears to extend north and south from 500 to 650 feet with a width of 165 feet. The ore is stated to contain from 30 to 40 per cent manganese.

As far as is known, the only manganese deposit in Uruguay being worked on any scale at present is a 16-foot vein composed of small stringers located at the Pantanoso, in the immediate vicinity of Montevideo. The owners, who are Argentines, claim to have invested about $100,000. Ore is being extracted at a depth of 90 feet. Most of the ore is hand picked. The concern exported to Argentina for use in glass factories some 16 tons of manganese ore from January to August, 1918, and the local representatives of the owners recently obtained an export permit for 100 tons of ore, which is not, however, ready for shipment. Official export statistics show that Uruguay exported 2 tons of manganese ore in 1915, none in 1916, and 1 ton in 1917.[1]

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[1] Daily Cons. and Trade Repts., Jan. 1, 1919.

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CHROMITE.

CHROMITE IN 1918.

By J. S. Diller.

GENERAL CONDITIONS.

The year 1918 was the most eventful in the history of chromite. The domestic production was by far the largest in the history of the country and demonstrated that when necessary the United States can, at least for a few years, supply its own chromite. To meet the urgent demands of the war for both information and supplies monthly reports of the production and shipments of chromite were obtained by the Geological Survey from the mine operators and railroad agents. The total quantity of chromite of all grades mined and shipped in the United States in 1918 was 82,430 long tons (92,322 short tons), valued at $3,955,567.

In 1916 the domestic production of chromite of all grades was 47,035 long tons, valued at $14 to $20 a ton. In 1917, notwithstanding the strong demand and the advance in the average price to $24 a ton, the shipments declined about 3,000 tons. It was felt, therefore, in the spring of 1918, that to meet the urgent demand for chromite extraordinary inducements should be held out to the miners. In consequence the prices were greatly increased on a stable scale for the year and the large production followed.

The increased production involved much development work, and as the maximum rate of output was not reached until about the end of August, 1918, victory soon stopped the demand for this ore, and producers were left with heavy bills to pay for the cost of production and with large stocks of unsalable chromite of declining value on hand. These and similar losses led to the passage by Congress of the War Minerals Relief bill, providing for a commission which is now adjusting the war minerals claims.

SOURCES OF CHROMIUM.

Chromium does not occur native but appears in about a dozen minerals in the form of oxides, chromates, sulphates, and silicates. Chromite, an oxide of chromium and iron, is practically the only commercial source of chromium. It is composed when pure of 68 per cent of chromic oxide and 32 per cent of ferrous oxide. In nature, however, some of the chromium in chromite is replaced by aluminum or iron. Much of the rich imported ore contains 50 per cent or more of chromic oxide, but the average American ore contains only about 40 per cent.

MODE OF OCCURRENCE AND ORIGIN OF CHROMITE.

Chromite is a common constituent of basic igneous rocks, especially of peridotite, which is composed largely or wholly of olivine or pyroxene. As rocks composed of olivine and pyroxene readily alter to serpentine and the chromite in them remains unchanged, the most common occurrence of chromite is in crystalline grains widely distributed in serpentine.

In places the grains of chromite in peridotite and serpentine instead of being scattered individually through the rock are segregated so as to form irregular bodies of ore ranging from a fraction of an inch to many feet in length and suitable for mining as a source of chromite. These ore bodies are generally lenticular or tabular in shape. In some places they are cross jointed and appear as dikes, an occurrence which might be expected from the fact that in nature the chromite generally if not always crystallizes from the molten igneous rock to which it belongs. The occurrence of chromite in veins deposited from solution in water has been reported, but such a deposit if verifiable is rare. Chrome-bearing silicates, such as chrome chlorite, chrome diopside, and chrome garnet, occur in veins cutting chromite, but the chromite itself belongs to an earlier period of development, having crystallized directly from its magma.

USES OF CHROMITE.

Chromite is used for making alloys, chemical compounds, and refractory materials.

The most important alloy is with iron in ferrochromium used in making chrome steel, which is remarkable for its hardness in resisting wear and penetration. Its principal application is in armor plates and shells for piercing them, as well as in special parts of airplanes, automobiles, and engines and in stellite for high-speed cutting tools and parts of other machinery. Chrome steel is extremely hard, tough, and dense. It possesses great tensile strength and is superior to any other metal known for the wearing parts of mills used in crushing. Chrome steel, though hard, bends well cold if the operation is slow enough. It can be welded to iron and rolled out and finds use in sheet metal and rod metal, especially as material for burglar-proof safes, wire, magnet steel, cutlery, bridge steel, tires, axles, springs, stamp-mill shoes and dies, crusher jaws, knuckles for car coupling, lathe tools, drills, and chisels.

The steel for shoes and dies for stamp mills if compressed hot in a hydraulic forging press removes internal porosity and renders the steel of equal density and wear resistance throughout.

> Chrome steel resembles in some respects the higher grades of tool steel but in addition is possessed of properties combined in no other known steel. It will harden drill proof against the finest tools when heated to a moderate heat and plunged into water.[1]

There are many special steels whose properties are determined by alloys of which chromium is an element. Among these may be mentioned stainless steel, made first in England for cutlery, but appreciated first in the United States; manufacture restricted during the war but lately greatly increased; also nichrome, a nickel-chromium alloy of great heat resistance.

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[1] Cirkel, Fritz, Chrome iron ore deposits in the eastern towhship of Quebec, p. 104, Canada Dept. Mines, Mines Branch, 1909.

Of the many chemical compounds of chromium among the most important are the chromates that are employed largely as pigments, dyes, and mordants, as well as for tanning.

As a refractory material chromite is used in a crude state or is manufactured into chrome brick.

In the United States in normal times about 35 per cent of the chromite is used for the manufacture of ferrochrome, 35 per cent for chemicals, chiefly bichromates, leaving 30 per cent for refractories and other purposes.

CONSUMPTION.

Early in 1918 estimates were made by the trade that 146,000 tons of chromite would be required for the industries during the year. These figures were later reduced to 130,000 tons, and the import program was prepared on that basis. Imports from distant overseas sources were cut down to a minimum, and the production in near-by countries, such as Cuba and Brazil, and in domestic mines was stimulated by direct appeals and high prices in order to bring the supplies up to requirements. There were also attempts to conserve the use of chromite in certain industries, as in tanning and refractories. Late in the summer of 1918 it was found that the consumption, was much less than estimated, and indications were that the total requirement for the year would not be over 100,000 tons. In the meantime imports had been coming in at about the rate anticipated and domestic production was larger than had been expected. This combination of circumstances led to the market becoming overstocked with chromite and the domestic producers being unable to sell their product, which has caused much dissatisfaction.

WAR RESTRICTIONS CONCERNING CHROMITE.

The restrictions concerning chromite during the world war had reference, first, to imports in order to save vessels for war traffic and, second, to the conservation of chromite by restricting both its exportation and its consumption.

As to imports.—The proclamation of the President, November 28, 1917, prohibited the importation of chromite or any ferroalloy or chemical extracted therefrom except under license granted by the War Trade Board, which designated (Dec. 15, 1917) the American Iron and Steel Institute as consignee, and after February 1, 1918, all imports of chromite had to be indorsed (licensed?) by the American Iron and Steel Institute.

All licenses for imports of chromite were withheld June 5, 1918, until further notice. Three days later imports were licensed from Cuba, Guatemala, Newfoundland, and Brazil. Licenses were issued for imports from New Caledonia not to exceed 10,000 tons, but on July 15 the amount was increased by 12,000 tons to be used as ballast for sailing vessels.

As the result of the large domestic production and of the importation, on November 12, 1918, all outstanding licenses except for shipments from Cuba, Canada, and Brazil were revoked.

On January 20, 1919, licenses for the importation of all commodities heretofore controlled were issued without clause requiring indorsement to any trade association.

As to exports.—For purposes of conservation the exportation of chrome-nickel steel was practically prohibited by placing it on the conservation list. To this was added, October 22, 1917, by the War Trade Board, chromium ore and its derivatives, but a year later matters had greatly changed. On November 22, 1918, licenses were permitted for the export of all chromium ores to all destinations without condition, and in December, 1918, chromium ore and its derivatives were removed from the export conservation list.

As to consumption.—To conserve chromite for war purposes its use in the manufacture of certain special steels not of importance in the war program was prohibited.

In the manufacture of refractories its use was restricted and the endeavor was made to substitute magnesite.

In the progressing readjustment since the war all restrictions as to imports, exports, and the consumption of chromite have been removed.

CHROMITE IN THE UNITED STATES.

The distribution of chromite mines in the United States is shown on the accompanying map (fig. 11). They are most abundant in California in the Sierra Nevada, the Coast Range, and the Klamath Mountains. Numerous mines occur in the Klamath Mountains of southwestern Oregon and in the Blue Mountains of eastern Oregon. A few mines occur in Washington, Montana, Wyoming, Pennsylvania, Maryland, and North Carolina.[1]

CALIFORNIA.

In California the occurrence of chromite is confined to peridotite or its alteration product serpentine, which generally crops out in the mountain ranges, especially the Sierra Nevada, the Coast Range, and the Klamath Mountains. The bodies of chromite are distributed irregularly in groups as marked on the map (fig. 11).

In the Sierra Nevada chromite deposits occur mainly in a great belt of serpentine dikes parallel to the range near the western base in the southern portion but rising into higher parts of the range farther north. The dikes occur in the Palezoic and Mesozoic rocks of the Mother Lode region, and the groups of mines are mainly in the western portion of the belt in Fresno, Tuolumne, Calaveras, Eldorado, Placer, Nevada, and Butte counties.

The Coast Range of California from Santa Barbara to the mouth of Klamath River is composed of igneous and sedimentary rocks of Mesozoic age. There is much serpentine irregularly distributed as intrusive masses in the Franciscan formation, and bodies of chromite occur at many points, generally in groups, as shown on the map, in San Luis Obispo, San Benito, Santa Clara, Stanislaus, Napa, Lake, and Humboldt counties.

The Klamath Mountains, in northwestern California and the adjacent portions of Oregon, are composed like the Sierra Nevada largely of Paleozoic strata penetrated by many intrusive rocks, of which serpentine is one of the most common. Although smaller in area than the Coast Range or the Sierra Nevada, the Klamath Mountains contain serpentine in greater abundance and more widely distributed. Chromite too, as shown on the map, is more evenly distributed than in the other ranges.

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[1] Reports giving greater details concerning the chrome deposits of North Carolina, by J. Volney Lewis; of Montana and eastern Oregon, by L. G. Westgate; and of the Klamath Mountains, by J. S. Diller, are now in preparation for publication by the Survey.

Alameda County.—About 15 miles southeast of Livermore, Alameda County, the railroad shipping point, four active chromite mines, the Newman, Mendenhall, Draghi, and Chroman, together produced 448 long tons of ore, of which less than half reached the railroad. The Newman and Mendenhall mines were in more or less continuous operation for several years, but the other mines were opened in 1918. The ore is generally of low grade but may be improved by concentration. About one-third of the output contained more than 45 per cent

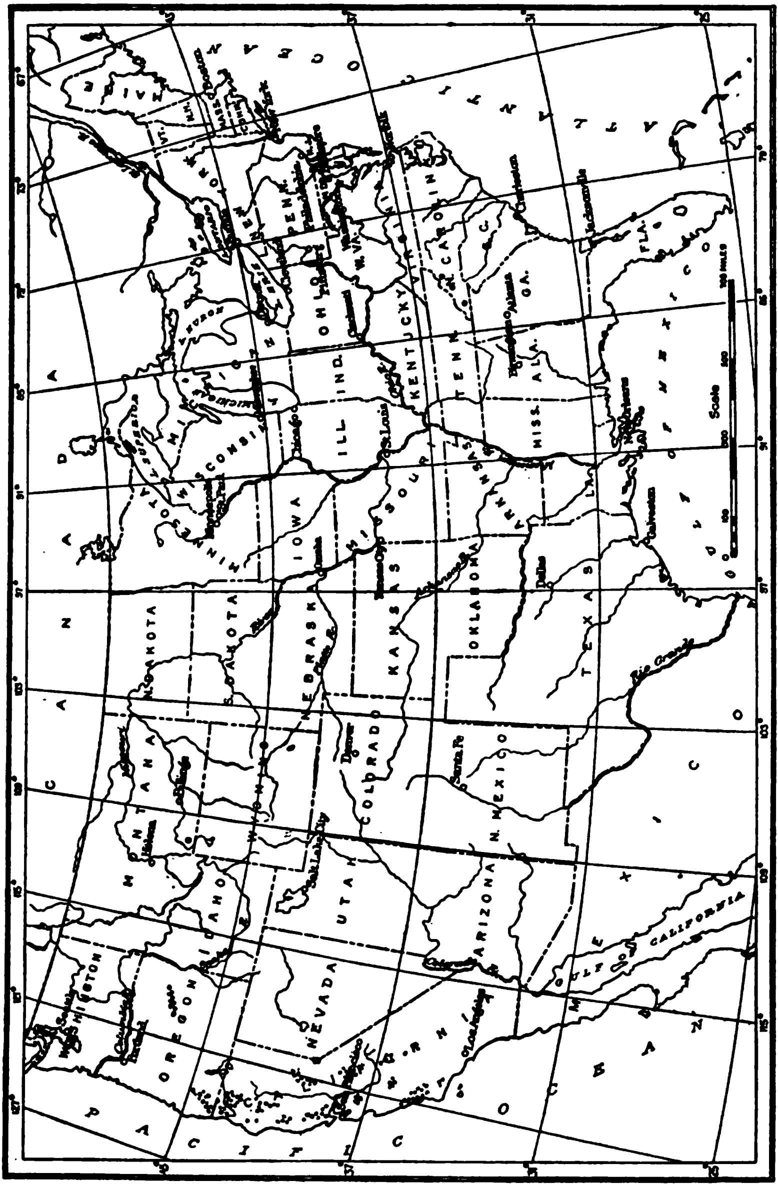
ATLANTIC OCEAN
PACIFIC OCEAN
GULF OF MEXICO
GULF OF CALIFORNIA
CANADA
MAINE
VT.
N.H.
MASS.
CONN.
NEW YORK
PENN.
OHIO
W. VA.
VA.
KENTUCKY
N. CAROLINA
S.C.
GA.
FLA.
TENN.
ALA.
MISS.
LA.
ARKANSAS
MISSOURI
ILL.
IND.
MICHIGAN
WISCONSIN
IOWA
MINNESOTA
N. DAKOTA
S. DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
N. MEXICO
COLORADO
WYOMING
MONTANA
IDAHO
UTAH
ARIZONA
NEVADA
OREGON
WASHINGTON
CALIFORNIA
Rio Grande
Scale

FIGURE 11.—Map of the United States showing distribution of chromite mines.

of chromic oxide (Cr_2O_3), but a somewhat larger proportion contained less than 35 per cent.

Amador County.—In the prominent dike of serpentine running north-northwestward across the western part of Amador County there are half a dozen chromite mines or prospects. Four of them were more or less active in 1918 and produced about 120 long tons, of which less than half was shipped. Some of the ore averaged 45 per cent of chromic oxide, but nearly two-thirds of it averaged as low as 35 per cent.

The total production of Amador County to the end of 1918 has amounted approximately to 1,000 long tons of 34 to 35 per cent ore. The output in 1918 was small, and the promise of ore in sight for future production is not encouraging. The chrome deposits of Amador County were examined for the Geological Survey by N. L. Taliaferro, of the University of California, in July and August, 1918, and the best deposit reported by him is that of the Detest ranch, which was not then under operation. The ore contains about 45 per cent of chromic oxide.

Butte County.—Butte County has been an active producer of chromite for three years. In 1916 the output was about 1,500 long tons; it declined in 1917, but increased in 1918 to 2,521 long tons, of which 1,387 tons was shipped. About a dozen active mines and prospects were in operation. The Swayne mines and the Lambert were the largest shippers. The Big Bend, Curtis, and Hendricks had notable outputs. The Hendricks mine had a small mill, which when the mine was exhausted was removed to the Taylor. Although the small output from Yankee Hill is reported as containing more than 45 per cent of chromic oxide the greater portion of the ore shipped from Butte County contained about 35 per cent.

Calaveras County.—The chromite deposits of Calaveras County occur in two more or less continuous main belts of serpentine, which is much sheared and altered. These belts cross the western part of the county in a northwest direction, and most of the mines are in the western belt. The various copper companies in the county are said to have used nearly 1,000 tons of local chromite prior to 1912, and about the same quantity was shipped from the mines of the county in 1917.

There were 19 mines and prospects reported in the county in 1918, and 15 of them produced 3,260 long tons, of which 2,517 tons was shipped. The three principal shippers were Ward & Lyons from the Lookout mine, Burham & Wilson from the Mayflower, and P. S. Dean from the Copperopolis. A considerable portion of the ore, as in the Mayflower and the Copperopolis, contains 45 per cent or more of chromic oxide; much of it, as in the Lookout, contains about 35 per cent. It is encouraging to note that Mr. Taliaferro has marked a number of the mines in Calaveras County as having good prospects for a considerable production. A mill was in operation by Holbrook & McGuire at the Chaparral mine and produced concentrates said to contain 39 per cent of chromic oxide.

Del Norte County.—Del Norte County produced more chromite in 1918 than any other county in the Klamath Mountains but ranked third when compared with Eldorado County, of the Sierra Nevada, and San Luis Obispo County, of the Coast Range.

There were 20 active mines and prospects in Del Norte County in 1918. The total quantity of ore mined and shipped was approximately 7,056 long tons and the estimated stock on hand December 31, 1918, was 3,879 tons. This large unsold stock was due to lack of market when production was most rapid.

The three principal producers were the American Exploration & Contracting Co. at the Low Divide and French Hill mines, Maltby & Adams at the High Plateau mine, and the California Chrome Co. at Gordon Mountain, although the greater part of the ore from Gordon Mountain has not been shipped. Crescent City was the principal point of shipment, mainly by boat to Eureka and San Francisco; much of the ore, however, especially that from High Plateau, was hauled to Waters Creek in Oregon and shipped by railroad through Grants Pass. The greater part of the ore contained 45 per cent of chromic oxide, and the remainder contained nearly 40 per cent; none fell as low as 35 per cent. Not only has the production in Del Norte County in 1918 been large and the price high, but the outlook for the future is equally promising.

Eldorado County.—Eldorado was the premier county of California in the production of chromite and in the United States was surpassed only by Grant County, Oreg., which, however, it excelled in quality of ore mined. Twenty-nine active mines and prospects are mentioned by Mr. Taliaferro, of which 26 were producers in 1918. The ore reported as shipped to market was 12,717 long tons, and the unshipped ore remaining on hand December 31, 1918, was estimated at 6,350 tons. The three principal producers in the county were the Steele Chrome Co., the Placer Chrome Co., and the Noble Electric Steel Co., which operated the Pillikin mine, all within a few miles of one another in T. 11 N., R. 8 E., on the same mass of serpentine. Its extent considered, this locality is one of the most productive yet found on the Pacific coast, and is comparable with that of San Luis Obispo County and with that of the Little Castle Creek region in Shasta County. The ore of the Pillikin mine is mostly of high grade, above 45 per cent; that of the Steele Chrome and the Placer Chrome runs from 40 to 45 per cent. Many of the properties, however, have low-grade ore, and there are mills at Rattlesnake, Salmon Falls, and Folsom for its concentration. Although much ore has been mined in Eldorado County there is still much in sight, with an encouraging outlook for future production.

Fresno County.—Fresno County occupies a large area on the western slope of the Sierra Nevada and stretches across San Joaquin Valley and up the eastern slope of the Coast Range, where also some chromite is found. East of the valley the county contains 54 chromite mines and prospects, of which about 30 have been active and 20 reported production in 1918. They are grouped in a small area about 25 miles northeast of Fresno, which extends northwest for about 12 miles. The ore is delivered to the railroads at Piedra and Clovis. The total shipment of chromite from Fresno County in 1918 was 2,674 long tons, and only 870 tons was reported as left on hand December 31, 1918. The output of the county has been decreasing gradually but decidedly since 1916, when the Clara H. mine was at the height of its production. There are many small bodies, but the larger ones in the Watt Valley region have been mined out. The grade of much of the ore was between 40 and 45 per cent of chromic oxide, although some of it was below 35 per cent. There is a small mill on a promising prospect in the Pine Flat district.

Glenn County.—The chromite mines of Glenn County are in serpentine at the south end of the Klamath Mountains. Chromite mining began here years ago, and more than 3,000 tons of ore was shipped from this county around Cape Horn to Philadelphia as early as 1893. The California Chrome Co. took out much ore here in 1916, when the production of the county was apparently the greatest in its history. In 1918 there were nine active mines and prospects, and the total production was 1, 773 long tons, of which 1,309 tons was shipped and 464 tons remained on hand December 31, 1918. The three principal producers were the California Chrome Co., Adams & Maltby at the Pinto and High Point mines, and Avery & Son at the Hill mine. The grade of the ore was fairly high. One hundred tons contained more than 45 per cent of chromic oxide. Much of it averaged 40 per cent, although a large quantity was under 35 per cent.

Humboldt County.—Humboldt County is in the Coast Range north of San Francisco, and the serpentine that contains the chromite penetrates the sedimentary Franciscan rocks. Four producers reported output in 1918 but only two shipped ore, and the total shipment was only a few hundred tons. The Horse Mountain region, which is the principal chromite center, is noted for its copper-bearing minerals. A number of deposits of chromite occur on Horse Mountain, and much of the ore averages 45 per cent of chromic oxide. Deposits of importance have been reported in the northern part of the county in the Klamath River region.

Lake County.—E. F. Davis, of the University of California, examined the deposits of Lake County for the Geological Survey and noted 23 mines and prospects, of which 13 were actual producers in 1918. The total shipment of chromite produced in the county in 1918 was 477 long tons, only 55 tons remaining in the hands of the miners on December 31, 1918. The production was small, but the grade of the ore and its almost complete shipment were due to the fact that the Sawyer Tanning Co., of Napa, Calif., by close inspection and collection, encouraged production and bought the ore from the mines for the manufacture of bichromates. The largest producing mines were the Lucky Strike, the Great Western, and the Deer, in all of which the ore is of high grade, containing 45 per cent or more of chromic oxide.

Mariposa County.—Mariposa County is in the Sierra Nevada. Small deposits of chromite have been reported at three points in the county. The most important is at the Riverside mine, 3½ miles south of Coulterville, which was operated in 1918 by T. C. Purcell, who mined and shipped about a carload of ore.

Mendocino County.—In Mendocino County there were six chromite mines and prospects in 1918, of which three reported a total production of 1,017 long tons. About half of the ore was shipped. The three producing centers were Red Mountain, Little Red Mountain, and Big Red Mountain, and each contains four or five claims. Although these groups of claims have attracted much attention they are practically undeveloped. Some of the ore is of high grade, but most of it is of low grade in promising large bodies.

Monterey County.—The Daisy mine, in Monterey County, is reported as having a large body of ore of good grade, but undeveloped transportation facilities prevented its shipment. The nearest shipping point would be King City. The Evans mine has a small undeveloped body of ore nearer the coast.

Napa County.—Napa County, like Sonoma, Lake, Mendocino, and Humboldt, is in the Coast Range north of San Francisco. It produces more chrome ore than any of the other counties in that region. E. F. Davis, of the University of California, who examined the chrome deposits of that region for the Geological Survey, reported 33 mines and prospects in Napa County, 13 of which were producers in 1918 and made a total shipment of 1,301 long tons. It is estimated that 476 tons was left unshipped at the mines. The largest producers were John Moore, George W. Elder, and the Sawyer Tanning Co. As in Lake County, the ore, which is of rather high grade, was mined and shipped under the influence of the Sawyer Tanning Co., of Napa. On account of the local demand for high-grade ore Lake and Napa counties have been more thoroughly prospected than any others in the State, and the fact that no important concentrating plant, such as must be the principal source of high-grade domestic ore, has been established is not encouraging.

Nevada County.—The serpentine belt of the western slope of the Sierra where it crosses Nevada and Placer counties contains important deposits of chromite. Of the 17 chromite mines and prospects noted in Nevada County 12 have reported a production, and the total shipments in 1918 amounted to 2,189 long tons, with 1,191 tons remaining in stock at the mines at the end of the calendar year. The three largest shippers were A. J. Schmidt, John Sweet, and T. R. Williamson. Most of the ore was of low grade, carrying less than 35 per cent of chromic oxide, although part of it contained between 35 and 45 per cent. In the Nevada City region several quartz mills were successfully converted into concentrators of chromite.

Placer County.—Placer County is next to Eldorado on the north and partakes of its richness in deposits of chromite. Out of a large number of mines and prospects about 20 reported both production and shipments of ore. The total shipments from Placer County in 1918 amounted to 3,644 long tons, and it is estimated that 1,195 tons remained in stock at the mines December 31, 1918. The three principal shippers were Adams & Maltby, Turner & Geisendorfer, and L. H. Butcher & Co. The ore shipped by Turner & Geisendorfer from a number of deposits contained from 45 to 55 per cent of chromic oxide, and only a small portion of the ore shipped from the county contained less than 39 per cent. The Auburn mine had a mill to concentrate its ore from an average of about 12 per cent to 45 per cent of chromic oxide.

Plumas County.—Plumas County is at the north end of the Sierra. Seven mines reported in 1918 a production of only a few hundred tons, of which about half (125 long tons) was shipped from Quincy Junction, mainly by the Union Chrome Co.

San Benito County.—On the eastern slope of the Coast Range, San Benito County, 8 mines and prospects have been reported. There were only two producers in 1918; the total output was small and most of it, although of good grade, remained unshipped.

San Luis Obispo County.—San Luis Obispo County is of nearly as great importance in the production of chromite as Eldorado, the premier producer of California. Fifty-five mines and prospects have been reported in San Luis Obispo County, but only 18 reported production and 14 reported shipments in 1918. The total quantity shipped was 9,935 long tons, and the estimated quantity of ore remaining at the mines December 31, 1918, was 2,900 tons. The three largest producers were the California Chrome Co. with its concentrator at the Castro mine, L. H. Butcher & Co. at the Trinidad and Pick and Shovel mines, and the Union Chrome Co. with mine and concentrator. Some of the rock ore carried more than 45 per cent of chromic oxide, but most of it contained between 40 and 45 per cent. From larger bodies of ore carrying about 25 per cent the output was concentrated to 42 per cent. San Luis Obispo County has probably produced more chromite than any other county in the State, and it evidently contains much more to meet future demands.

Santa Barbara County.—The 6 mines and prospects in Santa Barbara County are the most southern noted in the Coast Range. The output, combined with that of San Benito and Santa Clara counties, amounted to 700 tons of ore shipped in 1918. It is estimated that 824 tons remained in stock at the mines in the three counties. In Santa Barbara County the most active mines were operated by the O. & B. Co., and much of the ore ranges between 45 and 48 per cent of chromic oxide. Some of the ore in the O. & B. mine is remarkable for its concretionary structure. The outlook for future production in the group of prospects northeast of Los Olivos is encouraging.

Santa Clara County.—Northeast of Mount Hamilton in Santa Clara County there is a group of about a dozen prospects and mines from which there has been considerable production but small shipment of chromite. The Munition Metals Co., at the Coyote mine, was one of the most active. The Chroman mine, on the Winship estate, has been systematically developed and equipped under the management of E. J. O'Connell and T. S. O'Brien. The mine is 29 miles southeast of Livermore, with which it is connected by a good road. The property embraces approximately 2,000 acres, chiefly in secs. 1, 3, and 11, T. 6 S., R. 4 E., and sec. 7 of the adjoining township. It has been tested and developed by more than 700 feet of open cuts and tunnels. The ore, which is disseminated and partly banded with some rich streaks, is irregularly distributed. Generally the ore is of low grade and requires concentration, but it occurs in large quantities. The disseminated ore averages less than 10 per cent of chromic oxide, and the average of the whole body has been estimated by E. L. Young at 25 per cent. The ore grains appear to be all of high grade. Tests are reported to show that, whether the ore contains 10 per cent or 40 per cent, there is no trouble in concentrating it to better than 50 per cent of chromic oxide.

The following test of concentrates has been furnished by Mr. O'Connell:

Average composition of chromite concentrates from the Chroman mine, Santa Clara County, Calif.

	Per cent.
Cr_2O_3	54.1
SiO_2	2.8
Fe	16.1
P	.072

The new mill is complete and modern in every respect. It is equipped with both coarse-crushing and fine-grinding machinery. The table equipment consists of roughing, fine sand, and slime concentrating tables of the Deister-Overstrom type. This gives three-step concentration, insuring a high-grade product at all times, with a minimum loss in the tailings. There was a small production from this property prior to 1918, and the average grade of the ore shipped was 42 per cent of chromic oxide. A carload of rock ore and concentrates was shipped in 1918, but as the mill was completed just as the market failed, the mine has closed. The capacity of the mill is reported to be 300 tons of concentrates a month but can be readily increased if desired.

Shasta County.—Fourteen operators in Shasta County reported a production in 1918, but only 7 of them shipped any ore. The aggregate shipments amounted to 1,803 long tons, and 933 tons of ore remained in stock at the mines. The three chief producers were the Western Rock Properties Co. at Red Mountain in the Beegum region, the Union Chrome Co. at the Forest Queen, and the California Chrome Co. near Little Castle Creek. The largest body of chromite so far mined on the Pacific coast was on Little Castle Creek, in Shasta County, which yielded about 15,000 tons of high-grade ore. Shasta County is most favorably situated for mining and railroad shipment, and it may yet yield a large supply of chromite.

Sierra County.—In Sierra County, on the western slope of the Sierra Nevada, 11 chrome mines and prospects were examined and 8 reported a production, although only 3 reported shipments in 1918. In the summary table the shipments of Sierra County are combined with those of Amador, Mariposa, and Plumas, and the total is reported to be 419 long tons. The greater portion of it was shipped by Sierra County, and the tenor of the ore was chiefly between 35 and 45 per cent of chromic oxide.

Siskiyou County.—Siskiyou is one of the large counties of California and includes much of the central portion of the Klamath Mountains. There were 71 active mines and prospects in this county in 1918, and the greater number were actual producers, having total shipments of 5,469 long tons of all grades; 2,604 tons remained unshipped. The three principal shippers were S. H. Dolbear, Milne & Reichman, and Arthur L. Coggins. The ore ranged from 35 to 55 per cent of chromic oxide and averaged nearly 45 per cent. In the southern portion of the county there was great activity about Callahan, and the ore was shipped at Gazelle. In the northern portion the mines are in the lower drainage basins of Scott and Klamath rivers. The ore was shipped from Yreka and Hornbrook, and much of it was remarkable for its banded gneissic structure. The sudden stopping of the mines has left a large quantity of ore in reserve. There was little concentrating, although the county contains a large quantity of ore suitable for such treatment.

Sonoma County.—In Sonoma County, on the coast north of San Francisco, 7 mines and prospects have been noted, of which 5 have reported a production. The total output of chromite shipped from the county in 1918 was 821 long tons, and it is estimated that 129 tons remained at the mines. The three principal points of production and shipment are Camp Meeker, operated by S. H. Dolbear for the American Refractories Co., Healdsburg, and Guerneville. Nearly all the ore shipped contained between 35 and 45 per cent of chromic oxide.

Stanislaus County.—Stanislaus County stretches from the foot of the Sierra west across San Joaquin Valley into the Coast Range, where it is reported to contain 8 mines and prospects of chromite. Four active producers shipped a total of 2,684 long tons of ore in 1918 and reported 391 tons left at the mines. The three principal producers and shippers were the Mineral Products Co., the Chrome Concentrating Co., and G. L. Finster. About a third of the ore shipped is reported to contain 45 per cent of chromic oxide, but a somewhat larger proportion of the ore contains less than 35 per cent.

Tehama County.—Mines and prospects are numerous in Tehama County, especially in the southeastern and northwestern portions, but there were only 9 actual producers, which made a total shipment of 1,743 long tons. The estimated stock on hand remaining at the mines on December 31, 1918, was 4,277 long tons. This stock is unexpectedly large considering the convenience of the shipping facilities. The Noble Electric Steel Co. began mining in the Elder Creek region some years ago and had a large output in 1917. Near by are the Hillside and other mines operated by the American Refractories Co. and Adams & Maltby, also by W. E. Kleinsorge, who has a concentrating plant. The southeastern portion of the county affords much ore for concentration. The ore is hauled 30 miles to Red Bluff for shipment. In the northwestern portion of the county the Tedoc mine and many prospects have been active, especially in the Beegum region, where there appears to be considerable ore yet available, and in the vicinity of the State highway.

Trinity County.—Trinity County contains large areas of serpentine in two belts—one in the northern and the other in the southern portion of the county, and both contain many deposits of chromite. More than a dozen producers of chromite reported from Trinity County in 1918, but a number of them made no shipments. The total quantity of ore shipped during the year was 1,389 long tons, and 2,437 tons of mined ore remained in stock December 31, 1918. The principal shippers were Neely Bros., O. W. Kay, and Mattos, Green & Volonte. Most of the ore came from the south end of the county, reaching the railroad at Castella. Much of the ore ranged between 40 and 50 per cent of chromic oxide but the greater part was of lower grade. There are many undeveloped deposits in Trinity County, but they are far from railroad transportation.

Tulare County.—Tulare is the most southern county in the Sierra Nevada that produces chromite. Three producers from the Joyner and the Vaughn mines, near Porterville, made shipments of 562 long tons and left 112 tons in stock at the mines in 1918. Some of the ore is jet-black, coarsely crystalline, and of high grade.

Tuolumne County.—Tuolumne County, on the western slope of the Sierra Nevada, next south of Calaveras County, contains the southern portion of the Mother Lode, and near that rich belt of gold ores the serpentine has important bodies of chromite. Twenty-five mines and prospects were reported from that county in 1918, and among them 16 reported production, but only 10 reported shipments aggregating 1,479 long tons. The producers estimated a total of 596 tons left at the mines. The three principal producers were C. M. Quigg, Gene Grasselly, and Kerley & Van Winkle. Very little of the ore shipped carried more than 45 per cent of chromic oxide; two-thirds of it ranged between 35 and 45 per cent, and the rest was of lower grade. The prospects at a number of the properties are reported by Mr. Taliaferro as excellent.

Chromite shipped and remaining in stock in California in 1918.

County.	Shipments (long tons).	Stocks (long tons).[a]	Value of ore sold.	Average price per ton.
Alameda	167	281	$7,749	$46.40
Amador, Mariposa, Plumas, Sacramento, Sierra	419	688	20,591	49.14
Butte	1,387	1,134	56,900	41.02
Calaveras	2,517	743	134,746	53.53
Del Norte	7,056	3,879	380,536	53.93
Eldorado	12,717	6,350	556,586	43.77
Fresno	2,674	870	126,948	47.47
Glenn	1,309	464	72,046	55.04
Humboldt, Mendocino, Monterey	705	1,960	38,195	54.18
Lake	477	55	27,108	56.83
Napa	1,301	476	55,590	42.73
Nevada	2,189	1,191	82,107	37.51
Placer	3,644	1,195	195,705	53.71
San Benito, Santa Barbara, Santa Clara	700	824	46,453	66.36
San Luis Obispo	9,935	2,900	545,629	54.92
Shasta	1,803	933	89,328	49.54
Siskiyou	5,469	2,604	261,962	47.90
Sonoma	821	129	43,038	52.42
Stanislaus	2,684	391	77,026	28.70
Tehama	1,743	4,277	95,611	54.85
Trinity	1,389	2,437	57,021	41.05
Tulare	562	112	26,546	47.23
Tuolumne	1,479	596	80,730	54.58
	63,147	34,489	3,078,160	48.75

[a] Mined ore on hand (not shipped), Dec. 31, 1918.

OREGON.

A detailed account of the chromite mines of Oregon is given in reports on the chrome deposits of the Klamath Mountains, by J. S. Diller, and of eastern Oregon, by L. G. Westgate, now in preparation.

The chrome deposits of Oregon occur in two distinct areas, the Klamath Mountains, in the southwestern part of the State, and the Blue Mountains, in the eastern part. The Klamath and Blue mountains are composed of similar sedimentary and igneous rocks, whose northeasterly trend, corresponding with a line connecting the two ranges, shows that they are connected beneath the lavas of the Cascade Range. The chrome deposits of the Klamath Mountains occur in Jackson, Josephine, Douglas, Curry, and Coos counties; those of the Blue Mountains occur chiefly in Grant County, with smaller deposits in Wheeler, Baker, and Malheur counties.

Baker County.—In Baker County three operators reported output and shipments. The mines are on Conner Creek, about 16 miles north of Huntington. Their total output was not large, and the greater portion of it remained unshipped. The deposits are peculiar in being associated with limestone. Some of the ore contains 45 per cent of chromic oxide, but most of it contains less, some below 35 per cent.

Coos County.—Coos County is on Coos Bay and has the advantage of being able to ship by steamer direct to Portland or San Francisco or by railroad to the main line of the Southern Pacific Co. at Eugene. There were two active operators—one, the Krome Co., of Portland, at Rock Chrome, on Johnson Mountain, produced and shipped a small quantity of ore, and the other, the Suffern Co., of New York, having thoroughly prospected the old dumps of black sand on the lagoons northeast of Bandon, was about to begin production when the market broke.

Curry County.—Johnson Mountain and Iron Mountain have suggestive prospects in the northern portion of Curry County; in the southern portion the Bald Face mine is an important producer of ore which carries about 45 per cent of chromic oxide but has to be transported by autotruck 60 miles to the railroad near Grants Pass, on the main line of the Southern Pacific. The prospects in the black sand on the coast and in the rock ore of the mountains in this county are encouraging for the production of chromite.

Douglas County.—Douglas County is traversed by the main line of the Southern Pacific, which affords convenient transportation. Of the three active producers only two, the Oregon Nickel Co. and the Grants Pass Chrome Co., have made shipments. The chromite deposits of Nickel Mountain are of much interest in being of high grade and associated with nickel silicate similar to that of New Caledonia.

Coos, Curry, Douglas, and Jackson counties, all in the northern portion of the Klamath Mountains, have been rather small producers and shippers of chromite. The total shipment in 1918 was 686 long tons, and the estimated stock remaining on hand at the mines was 1,230 tons.

Grant County.—Grant County had 21 active producers of chromite in 1918, and of these 15 shipped ore. The total shipment of the county was 12,858 long tons, 2,213 tons remaining at the mines unshipped. Grant County was the premier county of the United States in shipping chromite in 1918, having exceeded by 141 tons Eldorado County, the leading county of California. It should be noted, however, that the ore in Eldorado County is of higher grade than that of Grant County and that Eldorado County, having less convenient shipping, had a much larger quantity of ore in stock December 31, 1918—6,350 tons, against 2,213 tons.

Jackson County.—Jackson County, near the California line along the eastern border of the Klamath Mountains, has at least half a dozen mines and prospects, of which three made a total shipment in 1918 of 150 long tons, 45 tons remaining unshipped at the mines. L. H. Van Horn is the principal operator on headwaters of the Applegate River, E. Vaughn on Pleasant Creek, and Cole & Thrasher on upper Grave Creek. A fifth of the output contained 45 per cent or more of chromic oxide, and the remainder contained more than 35 per cent. Prospects are fair for further production.

Josephine County.—Josephine County, on the California border, occupies the central portion of the Klamath Mountains, which contains not only the largest bodies of intrusive rocks in the State, especially serpentines, but also the richest metalliferous deposits, among which chromite is included. Twenty mines reported a production of chromite in 1918, but only 11 of them shipped ore. Their combined shipment was 4,818 long tons, and the estimated stock on hand December 31, 1918, was 3,271 tons. The three largest shippers were the California Chrome Co., the Grants Pass Chrome Co., and the Union Chrome Co. Many of the deposits are comparatively large and not yet exhausted, so that the prospects for available reserves are encouraging.

Malheur and Wheeler counties.—These counties are on the borders of Grant—one on the west and the other on the south. Both of them contain deposits of chromite but have not yet become considerable producers.

Chromite shipped and remaining in stock in Oregon in 1918.

County.	Shipments (long tons).	Stocks[a] (long tons).	Value of ore sold.	Average price per ton.
Baker and Wheeler	92	116	$2,681	$29.14
Coos, Curry, Douglas	536	1,185	32,575	60.77
Grant	12,858	2,213	549,883	42.76
Jackson	150	45	6,719	44.79
Josephine	4,818	3,271	263,192	54.62
	18,454	6,830	855,050	46.33

[a] Ore mined on hand (not shipped), Dec. 31, 1918.

WASHINGTON.

Workable deposits of chromite occur near Anacortes on Cypress Island and in the vicinity of Mount Hawkins, Kittitas County, Wash.

Some ore was shipped from Cypress Island in 1917 and 1918, and a large quantity of concentrating ore was developed by the Cypress Chrome Co. The rock ore contains about 47 per cent and the milling ore 25 per cent of chromic oxide. The milling ore has been tested at Seattle by the Faust Concentrating Co. and the Bureau of Mines and will concentrate to 45 or 50 per cent of chromic oxide. The ore bodies are irregular and scattered within an area of 3 or 4 square miles. A reserve of several thousand tons of concentrating ore is estimated.

A small shipment has been reported to J. T. Pardee from the Mount Hawkins region, in the eastern part of the State, where large areas of serpentine occur. The ore is said to assay 51 per cent of chromic oxide.

ALASKA.

Chromite was mined at Port Chatham, on the southwest end of Kenai Peninsula, Alaska, on a somewhat larger scale than in 1917. Freight rates in 1917 were $3.50 a ton from Port Chatham to Seattle and about $12 a ton thence by rail to an eastern smelter.

The ore bodies, according to A. C. Gill,[1] are in altered peridotite. They are as much as 150 feet in length and 20 feet in thickness. The ore shipped contained from 46 to 49 per cent of chromic oxide in 1917 and about 40 per cent in 1918. Much low-grade ore occurs in the vicinity that can be concentrated to 50 per cent grade, and it has been estimated that ore for 32,300 tons of concentrates is available above sea level.

At Red Mountain, 16 miles northeast of Port Chatham, and 6 miles from the nearest tidewater, many bodies of chromite occur. They have not been worked but are estimated to contain 195,600 tons of chromite.

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[1] Gill, A. C., Preliminary report on the chromite of Kenai Peninsula: U. S. Geol. Survey Bull. 712, pp. 99-129, 1919 (Bull. 712-D).

MONTANA.

In southern Montana between Red Lodge and Livingston notable deposits of chromite have been discovered and have recently attracted much attention. They were examined by L. G. Westgate, whose report is in preparation for publication by the Geological Survey. The deposits at Red Lodge are of less importance than those farther northwest, in the drainage basin of Boulder Creek, where there is a remarkable occurrence of chromite in a dike of pyroxenite. The dike is nearly vertical and has been traced about 30 miles N. 70° W., with a thickness ranging from half a mile to a mile. The pyroxenite dike, except the middle portion, is composed chiefly of enstatite that is but slightly altered to serpentine. The bodies of chromite are generally in bands or sheets in the middle portion of the dike, where they alternate with bands or sheets of rock composed largely or wholly of olivine. This medial belt of broadly banded chromite and olivine has a width of 90 feet in the Bonanza claim, and the widest band of chromite in the belt is 13 inches. In the Benbow claim the band of chromite ranges in width from 3 feet 4 inches to 5 feet 6 inches; in length it appears to be more or less continuous for 8,000 feet. The depth of the ore deposit is not definitely known, but the exposures on the canyon walls suggest a depth of 700 feet. The quantity of chromite to a depth of 100 feet is estimated at more than 200,000 tons. The ore is black granular chromite and generally contains less than 40 per cent of chromic oxide and about 18 per cent of iron oxide.

About 536 long tons of ore was mined here in 1918 by T. C. Benbow, M. W. Monat, and the Boulder Reeves Chrome Co., but as the means of transportation for 30 miles to the railroad at Big Timber were not quite completed there were no shipments in 1918.

The banded structure of the deposit, due to the parallel arrangement of the chromite and olivine in a belt or dikelike body within the large dike of pyroxenite, is of special interest and throws a strong light on the magmatic origin of the chromite. The dike of pyroxenite was formed first by intrusion into the inclosing rocks, and later the olivine and chromite were differentiated from the same magma as the pyroxenite was forced into it under such conditions as to develop a banded or gneissic structure.

WYOMING.

Chromite was discovered on Deer Creek 16 miles southwest of Glenrock, Wyo., about 1908, and a small quantity of the ore, possibly as much as 700 long tons, has since been mined and shipped. Operations ceased years ago until 1918, when the Ferro Alloy Co., of Denver, obtained control of the property. The chromite occurs in a belt of serpentine about 25 feet wide between granite and hornblende schist. It crops out about midway on the steep slope of Deer Creek canyon, which is nearly 1,000 feet deep. The body of chromite exposed in 1917 showed an irregular thickness of 2 to 5 feet and a more or less continuous length for 150 feet.

Chrome chlorites occur abundantly, forming veins and lining cavities in the chromite. In composition the chromite ranges from 35 to 44 per cent of chromic oxide with 16 to 20 per cent of iron oxide.

Tests of the ore for furnace lining are reported to have shown it too easily fusible for that purpose. The Ferro Alloy Co. uses it in the manufacture of ferrochrome.

The production and shipments of chrome ore from this locality in 1918 were larger than ever before, and the outlook for future production is reported encouraging.

PENNSYLVANIA AND MARYLAND.

The chrome industry of the United States was started by Isaac Tyson about 1828 in the vicinity of Baltimore, Md., and for many years the Maryland-Pennsylvania chrome region furnished the greater part of the world's supply. The Wood mine alone is said to have yielded a total output of about 95,000 tons of ore. With the development of the chrome mines in Asia Minor and elsewhere abroad the American production declined. A small quantity of chrome sand has been washed in the vicinity of Baltimore and exported in recent years for a particular use.

In 1918 the State Line mine, on the boundary of Pennsylvania and Maryland near Rock Springs, was unwatered by the Chrome Mining Co., and another old mine at Soldier's Delight, near Baltimore, was opened by the Maryland Chrome Corporation. There was a small output at each locality before the end of the war stopped operations.

NORTH CAROLINA.

Through the publications of J. H. Pratt and J. Volney Lewis the deposits of chromite in North Carolina became known years ago. In 1918 operations were carried on at five localities in Jackson, Buncombe, and Yancey counties. Seams and lenses of chromite are locally abundant but are generally small. One body yielded 7 long tons of ore, another 12 tons, and a third 25 tons. The ore is generally of high grade, containing more than 45 per cent of chromic oxide. There were five points of production with a total shipment of only 124 long tons, although the total quantity of ore mined was estimated at 339 tons. The principal producers were the Carolina Chrome Co., F. Hemphill, and the Consolidated Nickel Co.

J. Volney Lewis has recently examined the deposits of chromite in North Carolina, and his report is in preparation for publication by the Survey.

PRODUCTION OF CHROMITE IN THE UNITED STATES.[1]

The chrome industry of the United States began about 1828 in Maryland and developed so that the United States became the most important source of chromite in the world. The ore was mined first in Maryland and Pennsylvania, but later as the supply declined in the Eastern States deposits were found in California and the mineral was brought around Cape Horn in sailboats. Statistics are not available concerning this earlier production, but with the discovery of chromite in Asia Minor and its importation to the United States the domestic production declined and practically ceased from 1896 and 1897 to

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[1] Production includes only ore that has been sold and shipped; it does not include estimated stock on hand, mined but not shipped.

1900, when it revived to meet local demands for furnace lining. A small domestic production continued until the world war, when it suddenly expanded to the great output of 1918, which gives us confidence in our own resources.

Chromite of all grades produced in the United States, 1880–1918.

Year.	Quantity (long tons).	Value.	Average price per ton.	Year.	Quantity (long tons).	Value.	Average price per ton.
1880	2,288	$27,808	$12.15	1900	140	$1,400	$10.00
1881	2,000	30,000	15.00	1901	368	5,790	15.73
1882	2,500	50,000	20.00	1902	315	4,567	14.50
1883	3,000	60,000	20.00	1903	150	2,250	15.00
1884	2,000	35,000	17.50	1904	123	1,845	15.00
1885	2,700	40,000	14.81	1905	22	375	17.05
1886	2,000	30,000	15.00	1906	107	1,800	16.82
1887	3,000	40,000	13.33	1907	290	5,640	19.45
1888	1,500	20,000	13.33	1908	359	7,230	20.14
1889	2,000	30,000	15.00	1909	598	8,300	13.88
1890	3,599	53,985	15.00	1910	205	2,729	13.31
1891	1,372	20,580	15.00	1911	120	1,629	13.58
1892	1,500	25,000	16.67	1912	201	2,753	13.70
1893	1,450	21,750	15.00	1913	255	2,854	11.19
1894	3,680	53,231	14.46	1914	591	8,715	14.75
1895	1,740	16,795	9.65	1915	3,281	36,744	11.20
1896	786	6,667	8.48	1916	47,035	726,243	15.44
1897				1917	43,725	1,049,400	24.00
1898				1918	82,430	3,955,567	47.99
1899							

Crude chromite of all grades shipped and remaining in stock in the United States in 1918.

State.	Shipments (long tons).	Stocks [a] (long tons).	Value of ore sold.	Average price per ton.
California	63,147	34,489	$3,078,160	$48.75
Georgia, Maryland, North Carolina, Pennsylvania, and Montana	477	[b] 961	14,233	29.84
Oregon	18,454	6,830	855,050	46.33
Washington and Wyoming	352	407	8,124	23.08
Total United States	82,430	42,687	3,955,567	47.99

[a] Estimated ore on hand unshipped Dec. 31, 1918.
[b] Georgia, Pennsylvania, and Montana had no shipments but some stocks of ore on hand Dec. 31, 1918.

Chromite produced in the United States in 1918.

	Shipments.	Stocks.	Total mined.
All grades [a] ... long tons	82,430	42,687	125,117
Do ... short tons	92,322	47,810	140,132
Do ... metric tons	83,749	43,373	127,122
Ore carrying 50 per cent of chromic oxide ... long tons	68,747	35,601	104,348
Metallic chromium ... do	23,504	12,179	35,683

[a] Average grade for 1918—41.7 per cent of chromic oxide (Cr_2O_3).

The total shipments of domestic chrome ore in 1918 contained ore of a wide range in composition. Some shipments were reported to contain 55 per cent of chromic oxide, others to contain as little as 20 per cent. The output assembled in three groups is shown in the following table:

Chromite produced in the United States in 1918, by content of chromic oxide, in long tons.

	45 per cent or more.	35 to 45 per cent.	Less than 35 per cent.	Total.
Shipments	19,470	45,580	17,380	82,430
Stocks	11,470	17,344	13,873	42,687
	30,940	62,924	31,253	125,117

RESERVES.

Besides the 42,687 long tons of chromite mined but not sold December 31, 1918, there are large reserves difficult of access or distant from a railroad, but nevertheless available under urgent demand and in sufficient quantity to afford several years' supply for the United States.

EXPORTS.

Before the Civil War, when the United States was the principal source of the world's supply of chromite, the exports of chromite from this country were important, but since the discovery of the large deposits in Asia Minor and elsewhere abroad our exports of crude ore have practically ceased. Chromium compounds were placed on the conservation list, but that restriction has been removed.

IMPORTS.

It had been generally expected that, on account of the scarcity of ships and the dangers of the sea during 1918, the imports of chromite would be less than in 1917, but, as shown in the following table, they amounted to 100,142 long tons, or 28,079 tons more than in 1917. This increase was due chiefly to the fact that large imports came by land from Canada and also from new sources in neighboring coastal countries—Cuba, Brazil, and Guatemala—which together furnished 27,868 tons. This ore from neighboring countries is of low grade except that from Guatemala, which is a 58 per cent ore and remarkably rich even compared with other foreign ores. To facilitate the comparison of the imports in 1918 the crude ore for that year is in the following table all reduced to the 50 per cent grade and the conversion factor or grade of the ore is given.

There is no import duty on chromite, but there is an import duty on all chromium compounds. To protect the domestic chrome mining industry House bill 10305 was introduced by Mr. Kahn, October 31, 1919, imposing a duty of 60 cents per unit of Cr_2O_3 content on imported chrome ore, 11½ cents a pound on ferrochrome, 65 cents per unit of Cr_2O_3 content on chrome brick, 90 cents per unit on chemical compounds containing chromium.

Crude chromite imported into the United States, 1913–1918, in long tons.[a]

	1913	1914	1915	1916	1917	1918			
						Quantity imported.	Equivalent in 50 per cent ore.	Grade of ore imported (per cent).	Average price per ton in country of origin.
Brazil	....	....	....	....	....	17,854	16,069	45	$42.20
Cuba	....	....	....	34	17	8,821	7,057	40	36.40
Canada	....	533	10,087	12,220	19,012	20,949	12,569	30	31.56
England	....	58	2	5	5	4	4	50	150.25
Greece	4,600	8,155	4,305	7,900	....	....	....	....	....
Japan	79	....	....	....	....	....	....	....	....
French Oceania	21,850	30,860	28,031	[b] 30,950	10,300	25,761	28,337	55	12.55
Australia	....	....	....	[b] 2,986	....	15,976	17,574	55	41.88
British South Africa	....	....	22,800	[c] 23,000	4,750	521	521	50	....
Portuguese Africa	30,001	23,200	11,230	[c] 38,850	37,800	8,000	8,000	50	29.57
Turkey in Asia	8,650	11,880	....	....	....	....	....	....	....
Guatemala	....	....	....	....	179	1,193	1,384	58	65.32
Other British Oceania	....	....	....	....	....	1,063	1,169	55	11.81
	65,180	74,686	76,455	115,945	72,063	100,142	92,684	....	....

[a] Statistics compiled from records of Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.
[b] E. J. Lavino & Co., importers, credit New Caledonia with all ore listed under French Oceania and Australia, amounting to 33,936 long tons.
[c] E. J. Lavino & Co., importers, credit Rhodesia with all ore listed under British South Africa and Portuguese Africa, amounting to 61,850 long tons.

Chromium compounds imported for consumption in the United States, 1916–1918.[a]

	1916			1917			1918		
	Quantity.	Value.	Price per unit.	Quantity.	Value.	Price per unit.	Quantity.	Value.	Price per unit.
Chromic iron ore .... long tons	115,945	$1,548,402	$13.35	72,063	$1,110,659	$15.41	100,142	$2,892,825	$28.88
Chromic acid .... pounds	....	....	....	....	....	....	9,512	1,857	.19
Chromate and bichromate of potash .... do	459	75	.16	2,402	962	.40	20	8	.40
Chrome or chromium and ferrochrome or ferrochromium .... long tons	10	1,998	199.80	....	....	....	....	....	....
Chromate and bichromate of soda .... pounds	6,154	3,630	.59	22,025	4,075	.19	5,102	1,184	.23

[a] Statistics compiled from records of Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.

PRICES.

The average annual prices of chromite since 1880 are given in the table on page 674. The price was lowest in 1896, when domestic production ceased. It rose with the renewal of domestic production to $10 a ton in 1900 and has since increased, with notable variations, to the highest level in 1918. In order to increase the domestic production sufficiently in the early part of 1918 to supply the anticipated demands of the war it became necessary to increase greatly and also to stabilize the price of domestic ore. This was done by the offer of the chief consumer on March 17, 1918, to contract for the remainder of the year at a minimum price of $1.25 per unit of chromite carrying 38 per cent of chromic oxide. The offer was extended on June 4, 1918, to form a scale of prices varying according to the composition of the chromite from 30 to 48 per cent of chromic oxide (Cr_2O_3) as follows:

Prices of chromite, June 4, 1918, according to percentage of chromite oxide.

Percentage of chromic oxide.	Price per unit.	Percentage of chromic oxide.	Price per unit.	Percentage of chromic oxide.	Price per unit.
30	$0.85	37	$1.20	44	$1.40
31	.90	38	1.25	45	1.425
32	.95	39	1.275	46	1.45
33	1.00	40	1.30	47	1.475
34	1.05	41	1.325	48	1.50
35	1.10	42	1.35		
36	1.15	43	1.375		

Many contracts were made and carried out according to this scale of prices. Brokers appeared, however, who offered advanced prices, thus preventing and disturbing contracts. The action stimulated the market for a time, but when it became evident that the end of the war was approaching the large domestic production and the large imports soon overstocked the market and it broke, bringing disaster to many producers who, not having contracts to deliver, were unable to sell.

The moral obligation of the Government which had encouraged production to afford relief has been recognized in the appointment of a War Minerals Relief Commission, which is now carefully investigating losses thus incurred.

At present the trade journals do not quote prices for domestic chromite. The supply appears to come from imports only, of which the average composition and prices are given in the table on page 676.

WORLD'S PRODUCTION OF CHROMITE.

On account of the war the records of the world's production of chromite in 1917 and 1918 are incomplete. It is evident, however, that when the records are complete they will show a greater annual production than ever before. (See Pl. VI.)

Crude chromite produced by different countries from 1913 to the date of the latest available records, in metric tons.

	1913	1914	1915	1916	1917	1918		
						Production.	Conversion factor.	50 per cent grade.
United States	259	600	3,333	47,788	44,425	84,000	40	67,200
Canada	....	123	11,196	24,963	33,317	20,000	30	12,000
Cuba	....	....	....	35	17	9,000	40	7,200
Guatemala	....	....	....	....	182	1,200	58	1,400
Brazil	....	....	....	....	....	18,000	45	16,200
Great Britain	....	100	....	....	....	....	....	....
British South Africa	63,384	49,009	61,590	80,624	43,230	28,000	50	28,000
Turkey (Asia Minor)	14,000	14,000	14,000	14,000	....	14,000	55	15,400
Greece	6,930	7,059	10,420	9,880	6,750	10,000	48	9,600
Austria-Hungary	305	533	....	....	....	500	50	500
Russia	15,000	15,000	15,000	15,000	....	16,000	54	17,300
India	5,767	5,986	3,828	20,484	....	20,000	50	20,000
Australia	685	660	770	460	770	800	55	890
New Caledonia	63,370	71,708	57,474	57,024	41,892	26,000	55	28,600
Japan	1,331	2,108	2,979	8,280	8,939	8,000	40	6,400
	171,000	167,000	181,000	279,000	....	....	....	....

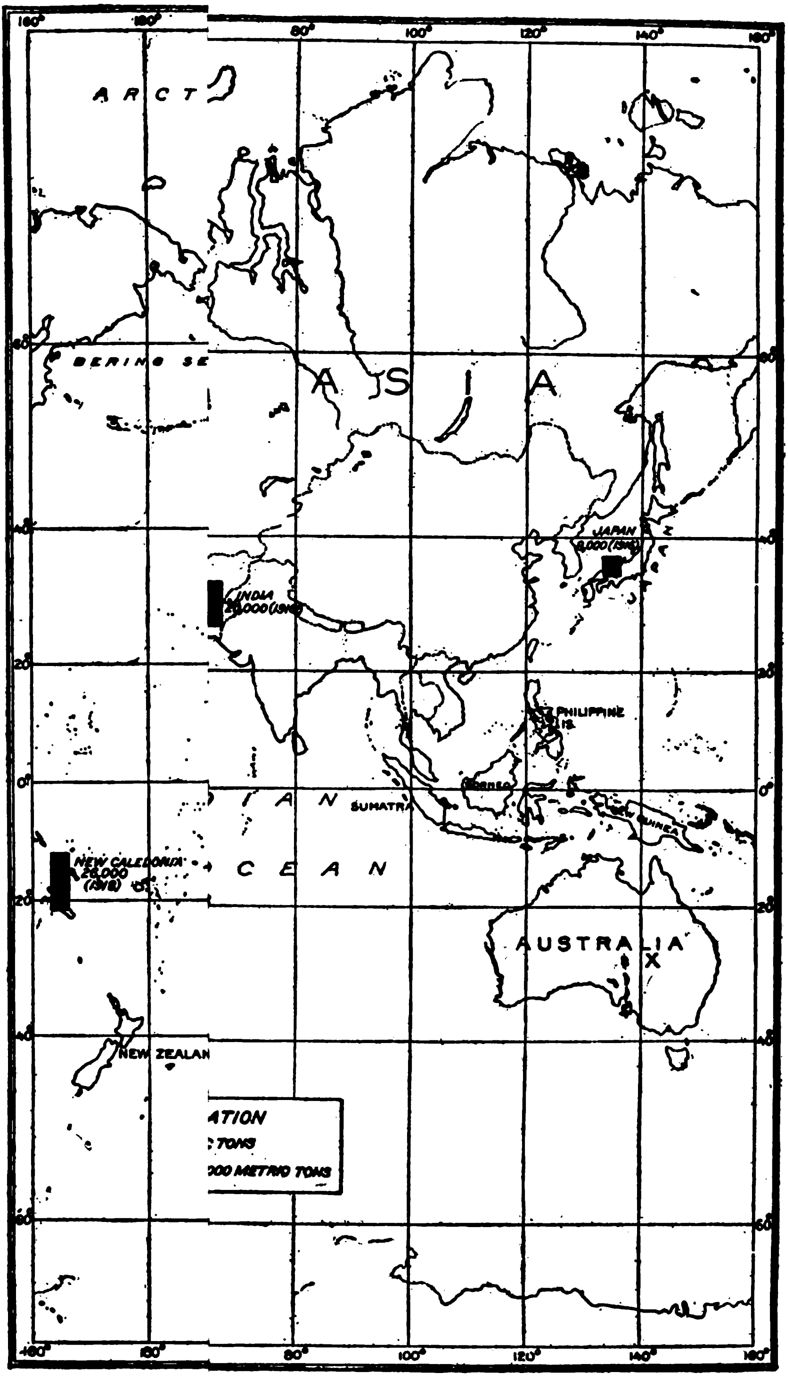
In 1913, before the World War, the greatest chromite producing countries were Rhodesia and New Caledonia; Russia and Asia Minor came next; and Greece, India, and Japan also produced large quantities. All these countries are in the Eastern Hemisphere. Of the world's production of 171,000 metric tons of chromite in 1913 only about 260 tons, less than two tenths of 1 per cent, came from the Western Hemisphere. Three years later, in 1916, a decided change had taken place. The United States and Canada had become important producers and chrome mines were opened in Cuba. The western continents in 1916 produced nearly 73,000 metric tons of crude chrome ore, or more than 26 per cent of the world's output. In 1917 the Americas yielded nearly 78,000 metric tons, and in 1918, when strenuous efforts were made to speed the production of chromite to win the war and the output of the United States, Brazil, Cuba, and Guatemala was so largely increased, the total production of the Western Hemisphere was more than 132,000 metric tons, possibly half of the total production of the entire world for that year.

OUTLOOK FOR THE MINING OF DOMESTIC CHROMITE.

The year 1919 opened with an oversupply of chromite from both domestic and foreign sources. The stagnated market had little sympathy for domestic ore, which is for the most part of relatively low grade, and the small sales appear to have been made in fulfilment of early contracts.

Reports to the Geological Survey have been made quarterly, and of the 692 correspondents only two, the Ferro Alloy Co., of Denver, Colo., and the L. H. Butcher Co., of San Francisco, Calif., reported in July a production and shipment of chromite within the first half of 1919. Seven reported shipments in 1919 of ore mined in 1918, and the total shipments in the first half of 1919 were 1,529 long tons, (1,713 short tons), of which nearly 85 per cent was produced in 1919 and only the surprisingly small proportion of 15 per cent was drawn from the large stocks (42,687 long tons) on hand December 31, 1918.

The ore produced in 1919 was mined in San Luis Obispo County, Calif., where the Ferro Alloy Co. operated the Souza mine, owned by


160°
180°
80°
100°
120°
140°
160°
ARCT
BERING SE
60°
ASIA
40°
JAPAN
2,000 (1916)
INDIA
26,000 (1916)
20°
PHILIPPINE IS.
0°
BORNEO
SUMATRA
NEW GUINEA
IAN
CEAN
NEW CALEDONIA
26,000
(1918)
AUSTRALIA
NEW ZEALAN
ATION
TONS
000 METRIC TONS

AILABLE.

P. A. H. Arata, and S. L. Schwartz operated the Pick and Shovel mine for the L. H. Butcher Co. It is understood that both mines have closed recently. The Ferro Alloy Co. is still operating the Deer Creek mine in Wyoming, which appears at present to be the only working chromite mine in the United States. The Ferro Alloy Co. uses its own output of chromite in its works at Pueblo, Colo., and may be able to supply local demands for refractory supplies. It is to be expected that other local demands, like that of the Sawyer Tanning Co., at Napa, Calif., may arise on the Pacific coast and call for local production and concentration at favorable localities.

The ore shipped thus far in 1919 has ranged in composition chiefly between 34 and 51 per cent of chromic oxide, that from California being the better. The range in prices for ore sold has been from $13 to $63 a short ton, with an average price of nearly $26 a short ton. The average price of the domestic product in 1918 was nearly $48 a long ton. The decline in the price of domestic ore since January 1, 1919, has been marked.

During the first half of 1919 19,658 long tons of chromite was imported. Nearly half of it came overseas, almost wholly from Oceania, and the average price in the country of origin is reported to have been about $36 a long ton.

As bearing upon the outlook for domestic chromite mining in the United States the great decline in 1919 in both production and market is practically overwhelming, sparing only localities favored by low cost of local transportation, high grade of ore, or low cost of production. On account of the long distance of the Pacific coast deposits from the chief market in the eastern part of the United States, the supplies, as before the war, are coming in by water transportation, but with the suggestive difference that increasing supplies may come in by coastal rather than by overseas trade.

FOREIGN DEPOSITS OF CHROMITE.

By E. F. Bliss and H. R. Aldrich.

INTRODUCTION.

The most valuable deposits of chromite in the world are in New Caledonia, Rhodesia, Turkey, and Russia. Less valuable deposits occur in India, Greece, Canada, and Australia.

Chromite was first mined in the Ural Mountains, in Russia. The ores are rich in chromic oxide and carry a variable content of silica. In 1913 the Russian output was consumed at home. Turkish chromite shows a variable content of chromic oxide (Cr_2O_3) and a low content of silica. It was extensively mined from 1860 until 1896, but since 1896 the production has been extremely variable. Until 1903 the Turkish chromite dominated the world's market, but from 1903 to 1913 New Caledonia supplanted Turkey as the chief source of the world's supply. In 1911 the Chrome Co. (Ltd.), of London, was formed to market the ores of New Caledonia and Rhodesia, and in 1913 these two countries dominated the world's market with an output of about 64,000 metric tons each. The ores of New Caledonia consist of chromite containing an average of 55 per cent of chromic oxide and of alluvial ores containing 30 to 40 per cent of chromic oxide. The content of silica varies considerably. The ores of Rhodesia are of high grade, averaging about 51.50 per cent of chromic oxide. Under normal conditions New Caledonia and Rhodesia will probably continue to furnish the world most of its chromite, though Turkey will supply considerable quantities of ore and will be an important factor in the world's market.

SCOTLAND.

Chromite is reported from several localities in Scotland.[1] It occurs in the Shetland Islands, in the Hebrides Islands, in Banffshire at Portsoy, in Aberdeenshire in the parishes of Kildrunomy, Toure, and Auchindoir, in Perthshire at Corrycharmaig in Glen Lochay, and in Stirlingshire and Ayrshire on the east side of Ben Lui. The only place where the mineral has been used as an ore is in the Shetland Islands.

In the Shetland Islands nodular massive chromite forming a tortuous vein in serpentine occurs in Uist Island, on the north side of Balta Sound. It is worked at Hagdale quarry, where the ore, which is black, forms a mass 86 feet deep and 60 feet wide. Chromite of dull-brown color is mined at Buness quarry. Ore, both massive and granular and of poor quality, occurs also at Haaf Gruney. In Tetlar Island the chromite is disseminated in small grains in serpentine at Vord Hill and Hestaness. It is granular at Quey Firth and occurs north of Bixter Voe Entrance and east of Kirk Ness. A chromiferous magnetite that might be used as an ore occurs both on Uist Island and on Tetlar Island. In Uist Island it occurs north of Dale Burn in sand as blue-black grains, not strongly magnetic. In Tetlar Island it occurs on Loch Tresta, according to Fleming, embedded in small grains in "primitive" limestone.

In 1881 [2] it was stated that chromite from India could not be profitably marketed "so long as England can obtain crude ore from Scotland and Styria in abundance."

In 1901 Heddle[3] speaks of an immense amount of work lately done in Sobul Hill, Uist Island, and alludes to the large size of the water-filled quarries and the quantity of stacked and unsalable ore.

In 1914 Great Britain [4] produced 100 tons of chromite valued at £50. The source of this ore is not stated, but it probably came from the Shetland Islands. None was produced in 1915, and there is no report of production in the mineral statistics of Great Britain from 1882 to the present time except in 1914.

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[1] Heddle, M. F., Mineralogy of Scotland, vol. 1, p. 100, 1901.
[2] Ball, V., Manual of geology of India, pt. 3, p. 324, 1881.
[3] Heddle, M. F., op. cit., p. 101.
[4] Mines and Quarries, General Rept., 1915, pt. 3, p. 113.

Analyses of chromite from Scotland.

	1	2	3	4	5	6	7
Cr_2O_3	44.56	48.03	26.34	44.20	41.00	9.4	17.53
FeO	17.52	18.08	34.11	24.93	23.14	24.94	15.55
Al_2O_3	23.74	16.55	18.28	7.47	12.15	....	....
Fe_2O_3	....	....	....	....	....	57.29	56.69
MgO	....	16.61	14.09	17.30	16.86	....	3.9
CaO	1.29	.88	6.38	....	....	1.12	1.29
SiO_2	11.09	.83	6.24	6.10	8.85	7.2	5.1
MnO	.5	Tr.	.75	....	....	.4	.6
	98.70	100.98	106.19	....	....	100.35	100.66

1. Chromite from Shetland Islands, Uist, Hagdale Quarry. M. F. Heddle, analyst, Mineralogy of Scotland, vol. 1, p. 100, 1901.
2. Chromite from Shetland Islands, Uist, Buness. M. F. Heddle, analyst, idem.
3. Chromite from Hebrides Islands, Rum, near summit of Askival. M. F. Heddle, analyst, idem.
4 and 5. Analyses made by A. Clouet, Mineral Industry, vol. 6, p. 147, 1897.
6. Chromiferous magnetite from Dale Burn, Uist Island. M. F. Heddle, analyst, op. cit. p. 99.
7. Chromiferous magnetite from Loch Tresta, Tetlar Island. M. F. Heddle, analyst, idem.

FRANCE.

In 1799 Citoyen Pontier sent in to Tassaert a specimen of chromite from Bastide de la Cassade, near Gassin, in the Department of Var.[1] The specimen, which was supposed by Pontier to contain zinc, turned out to be amorphous chromite and was analyzed by Vauquelin. (See below.)

In 1803 Tassaert[2] speaks of using the chromite mine in the south of France for the manufacture of pigments. In 1806 Vauquelin[3] reported chromite in the limonite ore of mines of Drambon.

In May, 1810, Leschevin[4] reported a green oxide of chromium associated with quartz at Les Ecouchets, in the Department of Saone et Loire, near Mont Cenis and Creusot. He said that chromium might be found later in some other form than the oxide. In the same article he mentioned chromite at Toulon as used in the arts but expensive.[5]

Analyses of chromite from France.

	1	2
Cr_2O_3 (chromic acid)	43.0	37.00
FeO	34.7	34.79
Al_2O_3	20.3	13.15
MgO	....	12.53
SiO_2	2.0	2.53
	100.0	100.00

1. Analysis made by Vauquelin on specimen of chromite from Bastide de la Cassade, Var: Jour. des mines, vol. 10, p. 521, 1801.
2. Analysis of chromite in rock reported by A. Clouet in L'Industrie, quoted in Iron and Steel Inst. Jour., 1886, No. 2, p. 809.

NORWAY.

Chromite has been found in Norway on Hestmandö and Rödö Islands, of the Nordland district, and in the Trondhjem district at Trondhjem and Röros (Feragen and Rodhammer).

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[1] Jour. des mines, vol. 9, p. 483, 1799; vol. 10, p. 521, 1801.
[2] Idem, vol. 14, p. 478, 1803.
[3] Idem, vol. 15, p. 390, 1806.
[4] Idem, vol. 17, p. 337, 1810.
[5] Idem, p. 308.

Vogt,[1] in his paper on the classification of ore deposits, describes most exhaustively the method of occurrence of the Norwegian chromite. He says that the chromite is associated in the Nordland district with a peridotite of the saxonite variety composed of olivine and enstatite and in the Trondhjem district with a serpentine derived from a peridotite. He emphasizes the universal genetic connection of chromite with olivine-bearing rocks and its absence in pyroxenites and amphibolites. Chromite occurs as a spotted ore and as massive ore in veins and in various combinations of these two ways. When the chromite occurs in grains disseminated throughout the saxonite it forms a chromite-saxonite varying in chromite content from 3 to 75 per cent. In some places a chromite-dunite, composed of chromite and olivine, forms veins and stringers containing 50 to 60 per cent of chromite. In other places chromite-saxonite or pure chromite associated with chromite-saxonite forms well-defined lenses or veins in normal saxonite. In general the chromite peridotites show all variations from 5 per cent to as much as 99 per cent of chromite.

Analyses of chromite from Norway.

	1	2	3
Cr_2O_3	42.00	40.80	[a] 54.080
FeO	19.72	37.77	25.661
Al_2O_3	12.00	4.80	9.020
SiO_2	5.00	4.20	4.883
MgO	21.28	13.23	5.357
	100.00	100.80	99.001

[a] Green oxide of chrome.

1. Analysis of typical chromite from Trondhjem. A. Clouet, analyst: L'Industrie, quoted in Iron and Steel Inst. Jour., 1886, No. 2, p. 809.
2. Analysis of grains in a spotted chromite from Christiania. A. Clouet, analyst, idem.
3. Analysis of chrome from Röros: Annales des mines, 2d ser., vol. 5, p. 316, 1829; original reference: Annales du Bureau des mines de Suède, vol. 9, 1825.

The production from 1830 to 1875, according to Vogt,[2] amounted to about 15,000 tons. Such other statistics as are available are given below.

Chromite produced in Norway, 1861-1865, 1873-1875.[a]

Year.	Quantity (short tons)	Value (crowns).
1861	650	....
1862	675	....
1863	650	....
1864	725	....
1865	300	....
1873 [b]	120	4,800
1874 [b]	230	9,000
1875 [b]	175	7,000

[a] Norges officielle statistik, 1866-1870, 1871-1873, 1874-75. [b] Trondhjem district, Röros.

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[1] Vogt, J. H. L., Zur Classifikation des Erzvorkommen: Zeitschr. prakt. Geologie, Jahrgang 1894, pp. 384-393.

[2] Idem, p. 392.

Chromite exported from Norway, 1861–1871.[1]

	Hundredweight.		Hundredweight.
1861	8,300	1867	
1862	6,500	1868	
1863	9,900	1869	4,200
1864	2,600	1870	5,600
1865		1871	117
1866	11,800		

Average annual exports of chromite from Norway, 1851–1870.

	Hundredweight.
1851–1855	3,500
1856–1860	5,900
1861–1865	5,500
1866–1870	4,300

Chromite produced in Norway, 1895–1905.[a]

Year.	Quantity (metric tons).	Value (kroner).	Year.	Quantity (metric tons).	Value (kroner).
1895	190	8,500	1901	85	[b] 2,000
1896			1902	22	400
1897			1903		
1898			1904	154	3,000
1899	41	800	1905		
1900	165	3,000			

[a] Official returns from Central Statistics Office, Christiania, quoted in Mineral Industry of Great Britain, Ann. Gen. Rept., vol. 3, and in Mineral Statistics for Great Britain, 1897–1905.
[b] Bulk of production at Röros. Strike closed mine from March, 1901, to January, 1902.

GERMANY.

Chromite occurs in Silesia. In 1887 Kosman[2] speaks of chrome ore discovered at Grochau, where a shaft was sunk in 1886. The ore contained no more than 35 per cent of chromic oxide (Cr_2O_3) and averaged from 19 to 26 per cent. The mine was abandoned because of the low grade of the ore.

In May, 1887, new openings were made on the northern flank of Haarteberg, near Grochau, and a deposit 2 feet thick was found in an old shaft. The ore, which carried 50 per cent of chromic oxide, contained some vanadium.

In 1894[3] a low-grade ore was mined on the southern slope of Mount Zobten, between Schweidnitz and Jordansmühl, about 15 miles southwest of Breslau. The ore body, which occurred in serpentine, was 23 feet thick and increased in magnitude as it went deeper. The ore was mixed with magnetite. The deposit was first mined by open cut, later by shaft and levels, but it was soon abandoned, as the material proved not sufficiently refractory for fire brick and contained too little chromic oxide for use in making chromates.[4]

Veins of chromite occur in serpentine near Frankenstein, but they have not been worked.[3]

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[1] Norges officielle Statistik, 1866–1870, 1871–1873.
[2] Iron and Steel Inst. Jour., 1887, No. 2, p. 228. Reference: Paper read before the Schlesische Gesellschaft für vaterländische Kultur, July 9 1887.
[3] Mineral Industry, vol. 2, p. 156, 1893.
[4] Stahl und Eisen, vol. 10, p. 1085; vol. 11, p. 643. Iron and Steel Inst. Jour., vol. 1, p. 251, 1891.

Analysis of chromite from Mount.Zobten, lower Silesia.[1]

	Per cent.
Cr_2O_3	35–42
Fe_2O_3	19–22
Al_2O_3	19–22
MgO	16–18
SiO^2	3– 5

No figures could be found on production in Germany.

AUSTRIA.

Chromite has been reported from upper Styria and from Moravia. The upper Styrian deposits occur in a serpentine mass intruded into the hornblende gneisses and granites. Gneisses of the Mur Valley, in the eastern part of the Tauern Alps, were known as early as 1808, when granular chromite in the Gensen Mountains near Kreiglach, was described.[2] This material was first mentioned by Karsten.[3] In 1811 Pantz [4] stated that this chromite really came from the little Gulse Valley, on the north bank of the Mur, between Kraubath and Seckau. It occurs as narrow veins or as disseminated octahedral grains in serpentine. It is associated with bronzite, clinochlore, and talc. Klaproth analyzed this material. (See analysis, p. 685.) The serpentinized peridotite[5] that contains the chromite runs along the Mur Valley from Kraubath northward to Leoben. The ore occurs on the right or south bank of the Mur in the Sommer Valley, and chromite occurs in sparing quantities on the north or left bank of the Mur in the Gulse ravine.[6] No mention is made of mining in Spur's book, but a reference[7] indicates that the chromite was mined before 1869.

In 1893 it was reported that the mine at Kraubath had not been worked since 1881. In 1895 [8] the Leoben district was worked by open cuts in the valleys tributary to Mur River. The ore occurred in small bunches and stringers and required crushing to raise it to 50 per cent of chromic oxide (Cr_2O_3). In Moravia,[9] west of Kroman, east of the Bohemian Moravian Hills, there is an area of metamorphic gneisses cut by dunite that is superficially altered to serpentine. The chromite, which is disseminated in small bunches and minute octahedrons in the serpentine, is exposed where the tributaries of Thaya River have cut ravines. It is not commercially profitable.

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[1] Mineral Industry, vol. 2, p. 156, 1893. No analyst quoted. Original references to Stahl und Eisen, vol. 10, p. 1085, vol. 11, p. 643.

[2] Leonhard's Taschenbuch, vol.. 2, p. 222, 1808.

[3] Jour. Chemie und Physik, vol 1, Bd. 2, p. 189.

[4] Leonhard's Taschenbuch, vol. 5, p. 371, 1811.

[5] Spur, D., Geologie der Steiermark, pp. 55, 72, Graz, 1871.

[6] Rvba, Franz, Beitrag zur Genesis der Chromeisenerz Lagerstätte bei Kraubat im Obersteiermark Zeitschr. prakt. Geologie, 1900, p. 337.

[7] Kahl, O., Der chrom Bergbau bei Krautath in Obersteier, Selbstverlag, Graz, 1870. Tunner's Berg- und Hüttenm. Jahrb. 1869, pp. 266-281, Prag, 1869.

[8] Mineral Industry, vol. 2, p. 155, 1893.

[9] Mineral Industry, vol. 4, p. 94, 1895.

Analyses of chromite from Styria, Austria.

	1	2	3
Cr_2O_3	53.00	56.2	55.50
FeO	24.92	9.1	33.00
Al_2O_3	8.00	13.7	6.00
MgO	11.58	9.7	....
CaO	....	6.4	....
SiO_2	2.50	4.3	2.00
Loss	....	....	2.00
	....	99.4	98.50

1. Analyses of Styrian ore reported by A. Clouet in L'Industrie, quoted in Iron and Steel Inst. Jour. 1886, No. 2, p. 813.
2. Analysis by Klaproth of chrome iron from Gulse Valley: Zeitschr. prakt. Geologie, vol. 8, p. 339. Original reference: Klaproth, Beitr. 4, pp. 132–136.
3. Analysis by Klaproth of a sample from Kreiglach, sp. gr. 45: Jour. des mines, vol. 27, p. 446, 1810. Original reference: Jour. Chemie u. Mineralogie, vol. 1, 1806.

In 1881[1] it was stated that from Scotland and Styria crude chromite was imported into England in such quantity that the India ore did not pay for exportation.

In 1908 the exports from Austria-Hungary[2] amounted to 1,435 metric tons, of which 1,118 tons went to Germany.

HUNGARY.

The only important working of chromite in Hungary is near Orsova, on the left bank of the Danube, where the ore is mined in open cuts at Ogradina, Dubova, Plavishevitza, Tsoritza, and Eibenthal. The chromite occurs in bunches in serpentine, and there is little waste. It is shipped by water down the river from Dreukova and is used in chemical works. In 1892 Busek & Co., of Vienna, offered ore graded at 38 per cent of chromic oxide (Cr_2O_3) for 33 shillings a ton f.o.b. Orsova. A ferrochrome works was erected before 1890 at Orsova by Gauss Bros., of Vienna.

Analyses of chromite from Hungary.

	1	2	3	4
Cr_2O_3	38.95	48.72	31.48	53.00
FeO	16.13	18.33	29.60	35.32
Al_2O_3	17.50	12.60	16.77	8.20
MgO	17.20	15.09	14.85	2.00
CaO	2.20	....	....	Trace.
SiO_2	8.00	5.26	7.30	2.40
	99.98	100.0	100.00	100.92

1. Grouvy, A., Ore from Orsova: Stahl und Eisen, vol. 1, p. 729; Imp. Inst. Bull., vol. 8, p. 397, 1910.
2. Ore from Alt-Orsova, Banat.
3. Hungarian ore in rock (no locality stated). Clouet, A., in L'Industrie, quoted in Iron and Steel Inst. Jour., 1886, No. 2, p. 809; also Mineral Industry, vol. 6, p. 147, 1897.
4. Ore from Orsova used in Gauss ferrochrome works. Iron and Steel Inst. Jour., 1889, No. 2, p. 316.

BOSNIA.

Chrome ore of good grade has been mined in Bosnia with a small but steady production. It was used in 1893 to line basic steel furnaces at the Diosgyor works, in Hungary. The mining district[3] is in east-central Bosnia, in a belt of serpentine extending from Banjaluka and Varesh to the Serbian frontier. It is bounded on the north by Krivaia River, a tributary through the Bosnia of Save River. The district is cut by three northward-flowing tributaries of the Krivaia. Small roads connect it with the Bosnia River Railway.

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[1] Manual of geology of India, vol. 3, p. 324, 1881.

[2] Mineral Industry, vol. 18, p. 93, 1909.

[3] Mineral Industry, vol. 4, p. 94, 1895.

The most important deposits are in the Dubostica Valley and extend over an area measuring 19 by 6 kilometers. They furnished the total output for 1902 under the management of a Viennese company. Other deposits occur in the Tribia Valley and the Krivaia Valley.

The workings are open cuts, and the ore occurs both in irregular disseminated stringers and in bunches, as at Rakovatz, and in faulted, layer-like ore bodies, as at Breznitza. Much of the ore is mined in hand-picked lumps that run 49 to 54 per cent of chromic oxide (Cr_2O_3). Disseminated ores are crushed in wet stamp mills and rock breakers, and are then concentrated by sluicing.

Analyses of chromite from Bosnia.

	1	2	3	4
Cr_2O_3	59.2	50.2	43.0	49.0
FeO	33.0	17.2	30.5	21.2
Al_2O_3	5.3	13.0	6.5	16.0
MgO	1.1	12.7	1.5	9.8
CaO	....	1.8	....	3.2
SiO_2	1.0	13.0	1.5	4.0

Analyses made by Patera and English chemical companies, 1 and 2 from twelve samples of hand-picked ores, 3 and 4 from six samples of concentrated ores. Mineral Industry, vol. 4, p. 96, 1895.

Chromite produced in Bosnia, 1892-1914.[a]

Year.	Quantity (metric tons).	Value.	Year.	Quantity (metric (tons).	Value.
1892	[b] 1,258.8 [c] 1,296	....	1904	278	[f] 18,952
			1905	186	[f] 13,048
1893	965	....	1906	320	[g] 543 [g] 799
1894	1,808	....			
1895	707	[d] 21,650	1907	310	[g] 1,031
1896	443	[d] 13,566	1908	500	[g] 1,457
1897	396	[d] 13,870	1909	332 ([e] 310)	[g] 967
1898	458	[d] 16,370			
1899	196 ([e] 200)	[d] 7,840	1910	320	[g] 960
			1911	250	[g] 739
1900	100	[f] 7,000	1912	200	[g] 542
1901	505	[f] 35,322	1913	305	[g] 1,000
1902	270	[f] 14,839	1914	533	....
1903	147	[f] 7,355			

[a] Original statistics compiled from Das Berg- und Hüttenwesen in Bosnien und der Herzegovina: Oesterr. Zeitschr. f. Berg- und Hüttenwesen.
[b] Mineral Industry, vol. 2, 1893.
[c] Idem, vol. 4, 1895.
[d] Florins estimated on basis of 1896.
[e] Figures in parentheses from Mineral Industry for 1899, 1909.
[f] Crowns (24 crowns=2 hellar=1 pound.)
[g] Pounds sterling.

SERBIA.

In Serbia chromium occurs at Ridjevstica,[1] at the foot of Mount Kopacnik, on the Svebrnica, in three forms—as compact, granular chromite ore, as fine-grained chrome silicate, and as a chrome mineral that forms a constituent component in decomposed mica schist. The mica schist is widely distributed in Roudin.

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[1] Jovitschitsch, M. Z., Soc. franç. minéralogie Bull. 35, p. 511, 1912.

Analyses of chromite from Serbia.

	1	2	3	4	5	6
Cr_2O_3	59.68	52.46	61.58	61.35	63.37	61.36
Fe_2O_3	30.59	15.26	26.39	27.13	22.83	25.14
Al_2O_3	6.23	14.01	6.47	8.77	8.45	10.77
MgO	3.89	7.62	3.34	3.10	2.98	3.65
CaO	1.25	.98	1.45	1.21	1.35	1.04
SiO_2	....	10.15	....	....	....	....
	101.64	100.48	99.23	101.56	98.98	101.96

1. Analysis of massive chromite from Ridjevstica-Jovitschitsch: Soc. franç. minéralogie Bull. 35, p. 511, 1912.

2. Analysis by C. V. John, chemical laboratory of Austrian Geological Survey, in years 1901–1903, of sample of chrome ironstone from Jelica-Planina at Cacak, sent in by B. Esterman in Vienna. K.-k. geol. Reichsanstalt Jahrb. 53, p. 502, 1903.

3, 4. Dark friable grains from concentrates, made from mica schist at Ridjevstica.

5, 6. Lighter, tough grains from Jovitschitsch: Soc. franç. minéralogie Bull. 35, p. 511, 1912.

The production of chromite in Serbia in 1901 was 100 metric tons, valued at 7,000 francs.[1]

In 1900 Jastrow [2] stated that a chromite mine had long been operated by the Government with poor results, though it was expected that in time success would attend the undertaking.

RUSSIA.

The chromite of Russia occurs in soapstones and serpentines of the Urals and in the northern Caucasus Range. The element chromium was discovered in the mineral crocoite, found in the Ural Mountains.

According to Gustav Rose, there are three classes of ore—large granular masses in serpentine, occurring near Ekaterinburg, 8 miles from Brissek, and near Kyschtinsk; disseminated ore, occurring at Mostrowaja, north of Ekaterinburg, and near Auschkul Lake; and ore in platinum and gold washings from the platinum placers at Nizhni-Tagilsk and the gold placers at Malo-Mostrowska. Massive ore occurs also at Orenburg. About 1892 M. Ushakoff [3] built a bichromate works at Elabouga, on Kama River east of Kazan. The importation of chrome salts into Russia ceased, and about 2,000 tons of native ore carrying from 45 to 47 per cent of chromic oxide (Cr_2O_3) was treated yearly. In 1909, 50 mines were operated in the Urals, and the average price at Ekaterinburg was 20 to 25 kopecks a pood ($5.75 to $7.15 a short ton).

The chromite in the platinum region at Nizhni-Tagilsk,[4] in the Province of Perm, occurs in a post-Devonian dunite intrusion on the divide between the Siberian and European drainage systems. Platinum is segregated by magmatic differentiation and the chromite is described as an early crystallization from the magma, closely associated with a later intergrowth of platinum which conforms to the outline of the chromite crystals that it incloses.

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[1] Min. Stat. Great Britain, 1901, p. 431. MacDonald, Trade of Serbia for 1897–98: Diplomatic and Consular Rept. 2207. Antula, Révue générale des gisements métallifères de la Serbie, Paris, 1900.

[2] Jastrow, Mining industries of Serbia: Eng. and Min. Jour., vol. 70, p. 523, 1900.

[3] Hadfield, R. A., Alloys of iron and chromium, Iron and Steel Inst. Jour., No. 2, p. 65, 1892.

[4] Wyssotzky, N., The Iss and Nischny-Tagil platinum: Reports of the Urals, St. Petersburg, 1913.

Besborodka [1] reports compact and granular chromite in serpentine 12 kilometers south of the village of Psemjonowka, Kuban Province, in the northern Caucasus. The ore carries about 60 per cent of chromic oxide (Cr_2O_3). (See analyses.) The chromium mineral fuchsite was discovered in a contact-metamorphic rock in the same district.

The production comes chiefly from the Ural district in Perm and to a less extent from Orenburg. The ore is both pure chromite and spotted ore and the average content of chromic oxide is between 54 and 55 per cent. Silica is variable between 1 and 7 per cent. Chromite was first produced as an ore in the Ural Mountains in the later part of the eighteenth century, and Russian ores were the only source of supply for compounds of chromium until 1827, when the ore from the United States began to furnish the world's supply. Production in Russia since 1901 has been considerably in excess of 10,000 metric tons a year. The maximum recorded was a production of 27,047 tons in 1905. The latest estimate of production was 16,000 tons for 1918. A considerable quantity of Russian ore is used in the manufacture of chemicals at Elabouga, and the remainder is used in refractories.

Analyses of chromite from Russia.

	1	2	3	4	5	6
Cr_2O_3	51.62	55.75	49.49	53.00	59.09	58.00
FeO	17.94	21.56	23.27	24.92	18.43	18.18
Al_2O_3	14.52	3.37	6.77	8.05	8.08	10.00
MgO	13.15	13.85	13.40	10.98	12.47	11.62
CaO	.73	.60	....	....	.91	....
SiO_2	1.71	5.37	7.07	3.05	1.66	2.20
MnO	....	....	....	....	.20	....
H_2O	....	....	....	....	.20	....
	....	....	....	....	101.04	....

1. Ore from bank of Kamenka River. M. W. Venator and E. Etienne, analysts, Chem. Zeitung, vol. 11, p. 53.
2. Ore from bank of Topkaja River. Same reference as No. 1.
3. Ekaterinburg. Imp. Inst. Bull., vol. 8, p. 397, 1910. Also reported by A. Clouet in L'Industrie, quoted in Iron and Steel Inst. Jour., 1886, No. 2, p. 809.
4. Orenburg. Same reference as No. 3.
5. Analysis of a sample of ore running 85 per cent of chromite from Kuban Province, northern Caucasus: Besborodka, Iron and Steel Inst. Jour., vol. 87, p. 508, 1913.
6. Analysis of chromite from Wiatka, Russia. A. Clouet, analyst, in L'Industrie, quoted in Iron and Steel Inst. Jour., 1886, No. 2, p. 809.

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[1] Iron and Steel Inst. Jour., vol. 87, p. 508, 1913.

Chromite produced in Russia, 1883–1916.

Year.	Quantity (metric tons).			Value.[a]
	1 [a]	2 [b]	3 [c]	
1883	1,900			
1884	500			
1885				
1886				
1887				
1888	4,156			
1889	7,221			
1890				
1891	3,097			[d] 94,500
1892	3,000	3,007		[d] 18,770
1893	14,600	14,585		[d] 87,700
1894	7,540	7,537		[d] 46,900
1895	2,101	21,014		[d] 13,060
1896	6,687	6,682		[d] 40,790
1897	13,433	13,433		
1898	15,780	15,467		
1899		19,146		
1900	8,233	8,233	18,800	
1901	22,169	22,169	22,000	[e] 14,235
1902	19,655		20,000	[e] 12,685
1903	16,421			[e] 10,597
1904	26,575			[e] 17,125
1905	27,047	27,051		[e] 17,548
1906	16,976	16,969	20,000	[e] 10,994
1907	26,357	25,258	26,000	[e] 17,125
1908	10,950	10,950	11,000	
1909	22,208	22,213		50,162
1910	14,379	1,362		23,207
1911		1,238		
1912		21,277		
1913	[f] 15,000			
1914	15,000			
1915	15,000			
1916	15,000			

[a] Mineral statistics of Great Britain.
[b] Mineral Industry.
[c] Statistique minérale de France.
[d] Silver rubles.
[e] Pounds sterling.
[f] Estimate by Russian geologists.

GREECE.

From 1892 until the present time the chromite mines of Greece have had a small but fairly steady production. The maximum was in 1904, when the total production was estimated at 15,430 metric tons, and the minimum was in 1897, when the production fell to 568 tons. Before 1892 the production was very irregular and ranged from 200 to 1,470 tons a year. Large intrusions of serpentine derived from peridotites occur over the Grecian mainland and on Euboea and other islands of the archipelago. Chromite occurs over this whole area, though deposits of economic value are of small extent. They occur in two ways—as chromite ore and as chromiferous iron ore.

Most of the chromite is produced in the southern part of Thessaly, in Magnesia, in the islands of Euboea and Skyros, and in Tinos Island[1] in the Cyclades. Chromite ores also occur in Lamia.[2] Chromiferous iron ores occur in Boeotia and Locrida.

In 1892 mining was carried on at Volo in Magnesia. In 1901[1] the Bourdaly mines, in the Kassidari Range south of the Thessalian plain, had an annual production of about 3,000 tons, valued at 70 francs a ton. The ore occured in massive form in a white or gray weathering product of serpentine. It averaged a little over 30 per cent of chromic oxide (Cr_2O_3) (see analyses) and was shipped chiefly to Austria for use in the manufacture of ferrochrome. Ore was also discovered in Magnesia in the Pelion Range at the Kissos silver mines. It was also reported from Tinos Island, in the Cyclades. In 1902 most of the chromite exported, 10,750 metric tons, valued at $40.31 a ton, was produced in the Magnesia district. In 1901 the exports from Magnesia were 4,750 tons,[1] valued at $16.31 a ton. In 1910 the whole production came from Pharsala, in Thessaly, and averaged 39 per cent of chromic oxide, and from 1911 to 1913 most of the exports were derived from Thessalian mines. Exports from Thessaly were,[2] in 1911, 3,200 metric tons; in 1912, 4,870 tons; in 1913, 5,300 tons.

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[1] Mineral Industry, vol. 10, p. 97, 1901.

[2] Imp. Inst. Bull., vol. 8, p. 280, 1910.

The most valuable deposits of chromiferous iron ore in Greece occur in Boeotia and Lokris.[3] Deposits have also been found on Euboea, Skyros, and other islands. Ore of this type was first discovered in 1901 by an Italian miner named Novara, in material from the Laurium lead-zinc mines.

The most important chromite mines in Greece in 1913 were the following:

	Owner.
Lokris	La Société minière Lokris.
Thebes	La Société hellénique des mines.
Karditza	La Société minière Bostic (not worked).
Tsouka	La Société des mines d'Atalanta.
Lutzi	The Greek Iron-ore Corporation (Ltd.).
Pavlorado	La Société des travaux publiques (not worked).
Skyros	La Société des mines de Skyros.
Politika	The Greek Iron-ore Co. (not worked).

The ores occur in irregular segregations and in lenticular ore bodies, in fissures in Cretaceous limestones (Thebes and Lokris) or as contact deposits between the serpentine and the limestone (Tsouka, Karditza, Lutzi, and probably Pavlorado). The longer axes of the deposits are usually parallel to the strike of the country rock.

The ore forms grains and nodules of brown hematite, in places very compact, as at Tsouka and Karditza, and in places very soft and not well suited to the blast furnace, as at Thebes, Lokris, and Lutzi. The deposits appear to owe their origin to magmatic differentiation and also to concentration.

The Grecian ores do not contain a high percentage of chromic oxide, rarely carrying more than 50 per cent, and for this reason they have been more used in the manufacture of refractories than in making ferrochrome or bichromates. Silica (SiO_2) in some specimens runs as high as 8 per cent.

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[1] Mineral Industry, vol. 11, p. 122, 1902. Compare this statement with figures for total production for 1901 in table of production.

[2] Mineral Industry, vol. 23, p. 98, 1914.

[3] Scott, H. K., Chromiferous iron ores of Greece and their utilization: Iron and Steel Inst. Jour., vol. 87, p. 447, 1913.

Analyses of chromite and of chromiferous iron ores from Greece.

	1		2	3	4	5	6
Cr_2O_3	32.30	Iron	46.00	52.00	49.00	50.00	46.00
FeO	41.00	Alumina	14.00	7.00	8.00	6.00	9.50
Al_2O_3	16.00	Silica	8.00	7.00	5.00	9.00	11.00
SiO_2	8.00	Chromium	2.50	2.00	2.00	2.80	2.50
		Nickel and cobalt	.60	.70	.40	.15	1.00
	97.30	Phosphorus	.02	.01	.02	.01	.03
		Sulphur	.03	.04	.03	.05	.02

1. Chromite from Bourdaly mine, Pharsala: Mineral Industry, vol. 10, p. 97, 1901. No analyst quoted.
2-6. Chromiferous iron ores. Analyses in the dry ore. Scott, H. K., Iron and Steel Inst. Jour., vol. 87, pp. 453-456, 1913. No analyst quoted.
2. Thebes and Lokris mines.
3. Tsouka mines.
4. Karditza mines.
5. Lutzi mines.
6. Skyros mines.

In 1907 185,000 tons of chromiferous ore was exported from concessions north of Mount Ptoon.

Total shipments of chromiferous iron ore from Greece at the end of 1912.

	Metric tons.
Lokris	430,000
Thebes	600,000
Tsouka	400,000
Lutzi	200,000
Skyros	300,000
	1,930,000

Chromite produced in Greece, 1888–1917.

Year.	Quantity (metric tons).		Value (francs except as indicated otherwise).	
	1 [a]	2 [b]	1 [a]	2 [b]
1888	[c] 212	....	....	....
1889	[c] 595	....	....	....
1890	[c] 800	....	....	....
1891	[c] 200	....	....	....
1892	[c] 1,470	....	....	....
1893	1,820	....	108,000	....
1894	6,000	1,500	360,000	95,000
1895	2,632	....	105,280	....
1896	1,402	....	56,080	....
1897	568	560	22,720	42,000
1898	1,367	1,400	54,680	93,000
1899	4,386	4,400	175,440	286,000
1900	5,600	5,600	224,000	364,000
1901	4,580	....	183,200	....
1902	11,680	11,700	467,200	367,000
1903	8,478	....	381,510	....
1904	15,430 [d] 6,530	8,900	576,040 [d] 244,875	....
1905	8,900	....	337,952	£ 13,518
1906	11,530 [d] 9,000	11,500	....	£ 17,295 £ 14,687
1907	11,730	11,700	497,000	£ 19,706
1908	4,350	4,300	176,000	£ 6,992
1909	[e] 9,600	....	434,000 * 430,655	£ 17,224
1910	9,450 * 7,000	9,000	* 400,600 * $96,668	£ 16,026
1911	* 4,615 12,915	....	[f] * $2,250	....
1912	* 6,468	....	....	....
1913	* 6,342	....	....	....
1914	* 7,059	....	....	....
1915	* 10,420	....	....	....
1916	9,880	....	....	....
1917	6,750	....	....	....

[a] 1888–1892, Annual general report of mineral industries for Great Britain, vol. 1, for 1894; original source L'industrie minérale en Grèce, rapport pour l'exposition à Chicago, published by Bureau of Mines, Ministry of Finance, Athens, 1893. 1893–1910, op. cit., vol. —, for ——; original source, official returns by the Greek Bureau of Mines. 1909–1915, figures marked * taken from Mineral Industry. 1916–1917, Tableaux statistiques du mouvement minier de la Grèce pendant l'année 1917.

[b] Statistique minérale en France; original sources, 1894–1900, Engineering and Mining Journal supplementary statistics; 1902–1907, Mines and quarries of Great Britain; 1907–1910, unknown.

[c] Tons.

[d] From Volo mines.

[e] From Thessaly chiefly, 48 per cent ore; also from Lamia and Euboea.

[f] Exported to the United States.

ASIA MINOR.

Chromite has been reported in Asia Minor from the following provinces or vilayets: Brusa, Smyrna or Aidin, Konia, Adana, Aleppo, Angora, Kastamuni, Syria, and Beirut.

Most of the output has come from Brusa in the north, from Smyrna in the southwest, and from Aleppo and Adana in the southeast.

BRUSA.

Chromite was first discovered in Asia Minor in 1848 by Prof. J. Lawrence Smith, near Brusa, about 57 miles southeast of Constantinople. Later discoveries were made near Harmandjick, 15 miles south of Brusa. The ores of Brusa province,[1] which are the richest and most abundant in Asia Minor, are found in the Brusa, Inegol, and Kutahia districts. The ores of the Kutahia district, which contains the most productive mines in Brusa province, lie on the southern, southeastern, and western slopes of the Mysian Olympus Range. Chromite occurs as superficial lenses and pockets in serpentine, locally in groups but in general singly. The serpentine is intruded into a series of schists overlain by a Tertiary limestone. The ore, which occurs in disintegrated rock, is soft and easily worked. Quarrying is carried on chiefly by open cuts, and the ore is hand-sorted and bagged. Only the most easily accessible ore had been mined up to the time of the war.

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[1] Weiss, K. E., Lagerstätten in westlichen Anatolien: Zeitschr. prakt. Geologie, vol. 9, p. 249, July, 1901.

The Daghardi or Alabarda mines,[1] which are near Harmandjick (Tschardy), about 40 kilometers south of Brusa, consist of three open cuts, worked under Turkish management. They were called by Doelter[2] the richest in the world and their reserves of ore were estimated at 10,000,000 tons. About 5 kilometers north of Daghardi on the same body of serpentine is the Kosludscha mine, owned by the English firm of Patterson & Co. The ore from these mines is hauled by camel, five camels to a ton, about 90 kilometers to Kutahia, whence it is transported by rail to Dernidje, near Ismid. In 1904[3] one-third of the annual output was shipped to the United States or Germany, the remaining two-thirds to England. The average yearly production was 10,000 to 12,000 metric tons of ore having a composition of 51 to 55 per cent of chromic oxide. In 1911[4] the ore was shipped to Glasgow, Liverpool, Antwerp, Rotterdam, Hamburg, Havre, and Marseille. At that time the price was $7 to $9 a ton on steamer, the lowest price in Turkey for ore of that kind.

The Brusa mining district is near Adranos, about 30 kilometers north of Daghardi. The Ateran,[5] Cozlundja, and Miram mines at Smyrna, belonging to Patterson & Co., produced about 6,000 to 7,000 tons a year. The ore was hauled by wagon 90 kilometers to Gemlek, the port of shipment. The price at Gemlek in 1904 was 45 marks a ton. In 1911[6] the output, estimated at more than 15,000 tons of ore assaying 55 per cent of chromic oxide, was shipped mostly to Germany.

Operating expenses of mining chromite per metric ton, Brusa district, Turkey.

Mining	$1.00
Taxes (20 per cent mining tax)	2.30
Management	.40
Export tax and miscellaneous wharfing charge	.23
Loading	.46
	4.39

The estimated profit was $6 a ton at a price based on 50 per cent of chromic oxide and a premium of 62 cents per unit of chromic oxide above 50 per cent.

Chromite was also mined in the Inegol district, southeast of Brusa, at the Bozbelen mine.[6] The mine was the property of Patterson & Co., and produced about 1,500 metric tons a year, which was shipped mainly to the United States. The price was 45 marks a ton at Gemlek in 1904.

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[1] Philippson, A., Reisen und Forschungen im westlichen Kleinasien: Petermann's Mitt., Erg. 38, Heft 177, p. 32, 1913.

[2] Doelter, C., Die Mineral-Beschätze der Turkei: Montanische Rundschau, No. 8, pp. 217–218, April 16, 1916.

[3] Simmersbach, Bruno, Zeitschr. Berg-, Hütten- und Salinenwesen preuss. St., vol. 52, p. 515, 1904.

[4] Leon, Dominion, Mining in Turkey in 1911: Min. and Sci. Press, vol. 104, p. 58, Jan. 6, 1912.

[5] Simmersbach, Bruno, op. cit.

[6] Leon, Dominion, op. cit.

SMYRNA.

Chromite in Smyrna Province was discovered near Makri in 1877. The geologic occurrence of the chromite is similar to that of the Brusa ores. Mining is carried on in two localities, near Denislie and near Makri.

The ore of the Denislie district, which was worked under Turkish management, lies chiefly near Tschardak, on the Smyrna-Ottoman Railroad. It contains about 56 per cent of chromic oxide and was considered to be a continuation of the Makri deposits.[1] Mining was carried on extensively, and the port of shipment was Smyrna. A few other mines in the Smyrna district had produced about 5,000 tons prior to 1904.

The Makri ores, which were the property of Patterson & Co., occur on the Gulf of Makri, and in 1904[2] they averaged only 40 per cent of chromic oxide, as the higher-grade material had been worked out. The ore was carried by camel to the sea and shipped from the port of Makri for 38.25 marks a ton. The Makri and Denislie ores were mentioned by Doelter[3] in 1916.

In the early days of the Smyrna industry the price was £12 a ton. In 1898 the price on a basis of 50 per cent of chromic oxide was £3 12s. a ton, with a premium of 1 shilling for each unit over 50 per cent. In 1902 Makri ore was quoted as $8.75 a ton at seaboard. As much as 30,000 tons a year, of an estimated grade of 48 to 51 per cent, was reported to have been shipped from Makri alone before 1898.[4] United States Consul Ernest S. Harris,[5] of Smyrna, reported that prior to 1906 the Makri district had produced and exported the greatest quantity of chromite in Asia Minor. In 1906 the price of chromite had dropped so low that there was no profit in mining it and the Smyrna concessions held by Patterson & Co. had been returned to the Government on account of the excessive annual tax.

KONIA.

The provinces of Aidin, Konia, Adana, Angora, Brusa, and Daghardi produced 27,102 tons of the Turkish exports of chromite for the year March 14, 1901, to March 13, 1902.[6] Doelter[7] in 1916 mentions six other mines in operation on the Gulf of Adalia. They must be the same mines referred to by Simmersbach in 1904 as belonging to a French syndicate and producing ore containing 55.5 per cent of chromic oxide. In 1904 the production from these mines was small. Five hundred tons was shipped in 1901 to Rotterdam.

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[1] Simmersbach, Bruno, op. cit.

[2] Idem.

[3] Doelter, C., Die Mineral-Beschätze der Turkei: Montanische Rundschau, No. 8, pp. 217–218, April 16, 1916.

[4] Thomae, W. F. A., Emery, chrome ore, and other minerals in the vilajet of Aiden, Asia Minor: Am. Inst. Min. Eng. Trans., vol. 28, p. 208, 1898.

[5] Mineral Industry for 1908, vol. 17, p. 128.

[6] Mineral Industry for 1902, p. 123.

[7] Doelter, C., op. cit.

ADANA.

Simmersbach[1] reports chromite in the Taurus Range of Cilicia in various localities—in the Lamas district west of Mersina, at Guara (ore 53 per cent of Cr_2O_3) and near Lamas (50 per cent); in the Alvanli district, on Tommak River between Itamin and Elbisik (53 per cent); also in Ala Dagh and between Gosneh and Mussali above Mersina. In 1911[2] it was stated that the mines near Mersina east of Anamur, would probably produce 2,000 tons of 50 to 53 per cent ore. It was rough sorted and shipped chiefly to Germany. The price was $19.50 a ton f. o. b. steamer.

In 1913[3] large mines were operating near Mersina. In 1916 Doelter[4] mentioned deposits in the vicinity of the Gulf of Adana.

ALEPPO.

Chromite[1] has been reported in Aleppo province at 12 localities northeast of Alexandretta in the region of Amanos, on Giaur Dagh, and at Kassab, on the flanks of the Cassius Mountains. Prior to 1911[1] some English capitalists started work on high-grade chromite ores near Aleppo. During 1911 deposits of chromite were discovered near Aintab, and in 1916 Doelter[4] mentioned rich deposits near the Gulf of Alexandretta.

ANGORA AND KASTAMUNI.

Deposits of chromite in Angora and Kastamuni are mentioned[5] as sources of the chromite production of Asia Minor, and[6] Weiss states that chromite occurs in Angora and Kastamuni. No other mention of these deposits has been found.

SYRIA AND BEIRUT.

A report was made prior to 1904 that chromite occurred at Catana, near Damascus, but the statement was not substantiated. It was also stated that chromite had been exploited by a Turk in the Laodicea district of Beirut. This deposit was not worked in 1904.[1]

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[1] Simmersbach, Bruno, op. cit.
[2] Mineral Industry, vol. 20, 129, 1911.
[3] Idem.
[4] Doelter, C., op. cit.
[5] Mineral Industry for 1902, p. 123; idem for 1904, p. 71.
[6] Weiss, K., Lagerstätten im westlichen Anatolien: Zeitschr. prakt. Geologie, vol. 9, p. 249, July, 1901.

ANALYSES.

Analyses of chromite from Asia Minor.

	1	2	3	4	5	6	7	8
Cr_2O_3	56.80	60.14	55.04	51.70	53.00	55.04	51.80	51.70
FeO	12.06	15.70	12.63	14.20	24.92	11.57	24.72	14.20
MnO	....	....	....	....	....	....	....	14.30
Al_2O_3	14.00	6.34	11.84	14.10	7.62	10.81	13.90	14.10
SiO_2	1.45	1.08	2.00	3.50	2.15	3.80	2.05	....
MgO	15.00	16.40	16.49	14.30	12.31	16.10	7.81	....
CaO	.70	....	1.46	1.70	....	1.13	.41	....
H_2O	.15	....	.40	.30	....	....	....	....
	100.16	99.66	99.86	99.80	100.00	98.45	100.69	94.30

1. Mineral Industry, vol. 2, p. 155, 1894. Analysis ascribed to H. G. Shaw, San Francisco, Calif.
2. Brusa ores. Imp. Inst. Bull., vol. 8, No. 4, p. 397. Analysis made in the scientific and technical department of the Imperial Institute.
3. Mineral Industry, vol. 2, p. 155, 1894.
4. Analyses ascribed to H. G. Shaw, San Francisco, Calif.
5. Ore from Karahissar. Mineral Industry, vol. 6, p. 47, 1898, quoted from A. Clouet, L'Industrie.
6. Average composition of Turkish chromite.
7. Mineral Industry, vol. 4, p. 101, 1895.
8. Ore from Turkey. Analysis quoted by J. A. Dresser in Canadian Min. Jour., vol. 30, pp. 365–367.

PRODUCTION.

There are no definite figures for total production or total exports of Turkish chromite prior to 1893, but the greater part of the chromite imported into the United States, the United Kingdom, and Germany came from Turkey in Asia.

Chromite imported into the United States, the United Kingdom, and Germany, 1882–1895.

Year.	United States.		United Kingdom.[a]		Germany.[a]
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (metric tons).
1882	....	....	13,057	£80,210	....
1883	....	....	5,454	26,795	....
1884	2,677	$73,586	10,283	51,553	....
1885	12	239	16,822	71,053	....
1886	3,356	43,721	10,990	44,105	....
1887	1,404	20,812	16,402	70,113	....
1888	4,440	46,735	14,315	65,095	....
1889	5,474	50,782	19,588	88,131	....
1890	4,353	57,111	18,968	90,036	....
1891	4,459	108,764	15,002	70,013	[b] 2,911
1892	4,930	55,579	14,902	65,266	3,950
1893	6,354	58,629	8,499	43,750	4,499
1894	3,470	38,364	....	....	12,171
1895	5,230	82,845	....	....	....

[a] Wilkinson, W. F., Chrome iron ore mining in Asia Minor: Inst. Min. and Met. Trans., vol. 3, p. 448, 1895.
[b] Estimated.

The following table gives such meager statistics as are available concerning the production of chromite in Asia Minor and other parts of the Turkish Empire. The figures are derived mainly from British diplomatic and consular reports.

Chromite produced in the Turkish Empire, 1892–1916.

Year.	Turkish Empire.		Smyrna.		Adana.		Constantinople and Marmora ports.	Adalia.		Mersina.	Saloniki.		Kossovo.	
	Production (metric tons).	Exports (metric tons).	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.	Quantity (metric tons).	Quantity (metric tons).	Value	Quantity (metric tons).	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.
1892		13,780												
1893	[a] 26,000	20,250												
1894	[a] 36,500	21,050												
1895	[a] 40,000	20,137												
1896		11,551												
1897														
1898											3,000			
1899							13,000				[b] 4,467	£18,948		
1900							12,000				[c] 9,749	24,467		
1901	[d] 40,972						14,000				4,900	14,400	2,800	£7,900
1902		27,102	1,037	£3,716						2,000	11,000		1,300	3,800
1903		2,030	2,030	8,066							9,000		400	1,000
1904			838	2,900		£500	7,000				8,000	7,000	3,700	8,370
1905						2,824					5,700	14,000	3,000	9,750
1906		1,500	1,080				13,000				5,600	18,000	4,100	12,000
1907						1,000		750	£3,000		4,900	14,400	2,800	7,900
1908	28,860		443								2,100	4,600	1,300	3,800
1909	11,546										895	2,400	400	1,000
1910											380			
1911											175	400		
1912														
1913	[a] 14,000													
1914	[a] 14,000													
1915	[a] 14,000													
1916	[a] 14,000													

[a] Estimated.

[b] Saloniki and Smyrna.

[c] Saloniki and Kossovo.

[d] March, 1900, to March, 1901.

SUMMARY.

Chromite occurs in Asia Minor chiefly at the north, in the Mysian Olympus Range; at the southwest, in the Smyrna district at Denislie and Makri; and at the southeast, along the Taurus Range of Cilicia. Most of the output has come from the Tschardy mines of the northern Brusa region and from the Smyrna district. The ore, which occurs usually in disintegrated rock, is soft and friable. It ranges between 40 and 60 per cent of chromic oxide (Cr_2O_3) and from 1 to 4 per cent of silica (SiO_2). Ore was first discovered in Asia Minor in 1848 and was not extensively worked until about 1860, when it rapidly supplanted the United States ore. It dominated the world's market until 1896, when the New Caledonia ores became an important rival to the Turkish ores. Statistics of Turkish production are unreliable, but up to 1897 Turkey in Asia is estimated to have produced about 20,000 metric tons a year. Since 1897 the production has been extremely variable. The maximum production recorded for a single year was 40,972 metric tons, between March, 1900, and March, 1901. As the records are those of exports and smuggling was extensively carried on from Turkish ports, it is probable that the low figures for some years are gross underestimates. In 1914 Turkey exported 11,880 metric tons to the United States. Her production since then is not recorded.

Mining in Turkey was carried on by the Turkish Government and by the English firm of Patterson & Co., at Smyrna. Exports went chiefly to the United States, England, and Germany. The excessive tax imposed upon mining concessions by the Turkish Government has been a serious handicap to successful marketing of the ore.

MACEDONIA.

Chrome ores have been reported from the Provinces of Saloniki, Kossovo, and Monastir. The port of shipment for these ores is Saloniki. In 1895 Wilkinson [1] mentioned shipment of ore at Saloniki from mines probably not far distant. Chromite was discovered about 1895 [2] at Uskub, in Kossovo Province, on Wardar River. In 1896 chromite mining in this region increased, owing to better transportation facilities; the chief mines were in Monastir and Kossovo provinces. The chromite mines of Elleshen,[3] a station on the Uskub-Mitrovitzka Railway, had a large output prior to 1901. The inrush of a stream cut down production, and late in 1901 these mines were offered for sale.

A number of mines were worked in the Uskub district of Kossovo in 1904.[4] The ore contained from 45 to 54 per cent of chromic oxide (Cr_2O_3). The best mine at Eiles Han was worked by the English firm of Patterson & Co. Oracha produced in 1903 3,845 tons of ore containing 45 to 50 per cent of chromic oxide. Most of the output was shipped to Marseille and Genoa; 957 tons was shipped to Lukovac in Austria.

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[1] Wilkinson, W. F., On chrome mining in Asia Minor: Inst. Min. and Met. Jour., vol. 3, p. 448, 1895.
[2] Mineral Industry, vol. 5, p. 120, 1897.
[3] Mineral Industry, vol. 10, p. 99, 1902.
[4] Simmersbach, Bruno, Zeitschr. Berg-, Hütten u. Salinenwesen, vol. 52, p. 520, 1904.

In 1904 chromite was exported from Saloniki, Kossovo, and Monastir. Deposits of chrome at Oracha were estimated in 1911 [1] as producing 1,000 tons, which was shipped to Austria. Exploration work was done during that year at Radicha and Carranza, near Uskub, and near Tikmesh.

Analysis of chromite from Macedonia.[2]

Cr_2O_3	55
FeO	13
Al_2O_3	10
MgO	15
SiO_2	7
	100

This analysis represents the best grade of ore from Monastir and Kossovo provinces.

The available figures on the production of chromite in Macedonia are given in the table on page 697.

INDIA.

Chromite occurs in northern India in the Provinces of Baluchistan, Kashmir, and Bengal and in southern India in the Provinces of Madras, Mysore, and Bombay. It has also been reported from the Andaman Islands and from Ceylon. The ore of northern India, though rich, is handicapped by poor facilities for transportation.

NORTHERN INDIA.

Ball [3] mentions an emerald-green stain on quartz rocks in the Kulu Punjab on Parbatti River between Mateara and Kusole, 150 miles southwest of Gwalior. It is probable that this substance is a magnesian silicate.

The most important deposit in the Himalayas is stream chromite, noted before 1865 on Hanlechu River [4] in Kashmir Province, on the northeastern slope of the range. The chromite, which is more or less crystalline, has a specific gravity of 4.208. That the ore must occur in the neighborhood in considerable quantity is indicated by the size of the pieces—cuboidal blocks of chromite 8 by 9 feet—in the walls of Hanle monastery. Some specimens are traversed by a mineral like uvarovite.

In 1879 Surg. Maj. Oldham [5] presented to the museum in Calcutta a specimen of chromite found in southern Afghanistan between Surkab Valley and Esab Kueh.

In 1903 [6] the India Geological Survey investigated the chromite that was discovered in 1901 in the Quetta-Peshin and Zhob districts, on the border between Baluchistan and the Punjab. The ore occurs in masses, and the Khanozai deposits in Peshin included an ore body 400 feet long and 5 feet wide, containing chromite which averaged 54 per cent of chromic oxide (Cr_2O_3). In 1903 [7] the ore was opened for export. The exports from Baluchistan, shipped from Karachi, have continued more or less steadily until 1913.

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[1] Leon, Dominion, Mining in Turkey in 1911: Min. and Sci. Press, vol. 104, p. 58, Jan. 6, 1912.
[2] Mineral Industry, vol. 5, p. 120, 1897. No analyst is given.
[3] Ball, V., Manual of geology of India, vol. 3, p. 333, 1881.
[4] Mallet, V., India Geol. Survey Mem., vol. 5, p. 166, 1865.
[5] Mallet, F. R., Manual of geology of India, pt. 4, p. 58, 1887.
[6] Wredenburg, ——, India Geol. Survey Rept. 1903, p. 9.
[7] India Geol. Survey Rec., vol. 46, p. 28, 1915.

In Bengal Province a specimen of chromite was found in the Singhbhum district in 1907.[1] Prospecting revealed an ore occurring in irregular veins and scattered granules in serpentine near Suru Pass on the Bengal-Nagpur Railway. The ore analyzed 50.05 to 53.19 per cent of chromic oxide. The ore was exported in 1913–1915 by Schroder, Smidt & Co. from the Saitba block of the Kolhau Government estate.

SOUTHERN INDIA.

In Madras Presidency a chromite mine was opened before 1861[2] in the Chalk Hills on the southwestern flank of the Shevaroy Hills, in the Salem district. The chromite is distributed irregularly in magnesite veins that form a network in layers of serpentine intruded into the hornblende-mica schists and talc schists of the district. The mines were opened by the Porto Novo Iron Co. and were worked to a depth of 50 to 60 feet. It is stated that after the first 100 tons was taken out mining became difficult, probably because of the presence of water. Exportation of the crude ore did not pay, and when the mines were visited by King and Foote in 1861, they were deserted and inaccessible. In 1881[3] it was considered that England could import sufficient crude ore from Styria and Scotland at a lower cost than that required to bring the Indian ore to the British chrome works. Moreover, it did not appear that the erection of a chrome works in India would be a profitable undertaking at that time. It was reported by Newbold[4] that chromite occured at Yedichicolum on Cauvery River, near Trichinopoly. Balfour[5] mentioned a sample of chromite from Vizianagram shown at the Madras Exhibition. According to Mallet,[2] the Madras deposits were being worked in 1887, but in 1904[6] they had again been abandoned.

It was reported in 1881[3] that chromite occurred in Mysore at Bengalore, also near Hoonsoor, and it was stated in 1887 by Clark, through Balfour,[7] that a considerable deposit of chromite had been found in the compound of Yehwal Residency, in the Ashtagram division. In 1907 for the first time, subsequently also in 1908 and 1909,[8] Mysore was a producing district. The ore was mined at Kadakola,[9] where 30 to 50 per cent ore was reported in veins and lenses in altered dunite. In 1913[10] the most important chromite mine in southern India was at Tipatur, 90 miles northwest of Bangalore. This mine produced about 2,600 long tons annually. Nearly all of this output was sent to the United States.

In Bombay Presidency[11] a large outcrop of ore carrying 34 per cent of chromic oxide (Cr_2O_3), occurs in serpentine 60 miles from Ratnagar. The outcrop measures 1,000 by 300 feet.

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[1] India Geol. Survey Rec., vol. 46, p. 30, 1915.

[2] Mallet, F. R., Manual of geology of India, pt. 4, p. 53, 1887.

[3] Ball, V., Manual of geology of India, vol. 3, p. 333, 1881.

[4] Roy. Asiatic Soc. Jour., vol. 2, p. 169.

[5] Balfour, ——, Encyclopedia of art.

[6] Mineral Industry, vol. 13, p. 70, 1904.

[7] Balfour, ——, Iron ores of the Madras Presidency. Mallet, F. R., Manual of geology of India, pt. 4, p. 53, 1887.

[8] Annual general reports upon mining industries of Great Britain for 1908 and 1909.

[9] India Geol. Survey Rec., vol. 46, p. 31, 1915.

[10] Diller, J. S., U. S. Geol. Survey Mineral Resources for 1913, pt. 1, p. 12, 1914.

[11] Mineral Industry, vol. 20, p. 128, 1910.

ANALYSES.

Analyses of chromite from India.

	1	2
Cr_2O_3	47.50	33.5
FeO	35.70	....
Al_2O_3	9.30	24.2
MgO	6.00	....
SiO_2	1.50	41.2
H_2O	....	1.1
	100.00	100.0

1. Analysis of Indian chromite by A. Clouet, quoted in Iron and Steel Inst. Jour., 1886, No. 2, p. 809.
2. Analysis of mineral resembling uvarovite in chromite of Hanle district. Analyst, Tween, India Geol. Survey Mem., vol. 5, p. 166, 1865.

In Solly's report on Salem ore, quoted by Newbold,[1] a sample of tolerably pure ore from the Salem district is said to show 49 per cent of chromic oxide (Cr_2O_3), equivalent to 57 per cent of chromic acid.

ANDAMAN ISLANDS.

Loose blocks of chromite were found in 1883 by Mr. M. V. Portman at Chakargoan village, near Port Blair, in the Andaman Islands. An ore mass 9 inches by 4 feet and showing at the surface was also reported.[2] Mallet could not find the deposit in place but considered that it might come from serpentine underlying the alluvial flat at the base of the hill. He says the absence of many fragments indicates that the outcrop is small.[3]

Chrome sand occurs in the streams of Rutland Island, south of Port Blair, and in one place the chromite crystals, concentrated out of serpentine, which is abundant in Port Blair, form a layer 1 inch thick.

CEYLON.

Chromite is reported [4] to occur in river gravels near Kondurugla, Bambarabottuwa, and a sample of black magnetic chromite from that locality was analyzed in the scientific and technical department of the Imperial Institute [5] (analysis 1 in the table on p. 702). Crystals of chromite coated with magnetite were analyzed in the same department with the results shown in column 2 of the table.[6]

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[1] Manual of geology of India, vol. 3, p. 333, 1881.

[2] India Geol. Survey Rec., vol. 16, p. 204, 1883.

[3] Idem, vol. 17, p. 83, 1884.

[4] Report on results of mineral survey of Ceylon, pt. 4; Colonial Report, Misc. No. 74 (Cd. 5390), p. E 17 1907.

[5] Idem, Colonial Report, Misc. No. 87 (Cd. 7175), p. 7, 1914.

[6] Imp. Inst. Bull., vol. 8, p. 347, 1910.

Analyses of chromite from Ceylon.

	1	2
Cr_2O_3	53.80	46.58
FeO	35.74	19.90
Fe_2O_3	1.54	25.05
Al_2O_3	2.02	2.86
MnO	.78	....
MgO	5.88	5.63
SiO_2	1.64	Trace.
	101.40	100.02

W. R. Dunstan, director of the Imperial Institute, says that the material would be a valuable chromium ore but that it probably does not occur in sufficient quantity to repay exploration.

PRODUCTION.

Chromite produced in India, 1861–1916.[a]

Year.	Quantity (long tons).				Value.			
	Total.	Baluchistan.	Mysore.	Bengal.	Total.	Baluchistan.	Mysore.	Bengal.
1861	100	....	....	....	....	200 fr.	....	....
1889	[b] 1	....	....	....	....	200 fr.	....	....
1894	16 cwt.	....	....	....	....	£8	....	....
1903	284	248	....	....	....	327	....	....
1904	3,596	3,596	....	....	....	4,137	....	....
1905	2,708	2,708	....	....	....	3,482	....	....
1906	4,375	4,375	....	....	....	7,188	....	....
1907	18,303	7,274	11,029	....	£24,404	9,699	£14,705	....
1908	4,745	4,135	610	....	6,338	5,513	825	....
1909	9,250	4,325	4,925	....	7,737	5,767	1,970	....
1910	1,737	1,737	....	....	2,315	2,315	....	....
1911	3,804	3,804	....	....	5,072	5,072	....	....
1912	2,890	2,890	....	....	3,849	3,849	....	....
1913	5,676	3,414	1,414	848	2,435	1,162	821	£452
1914	5,882	3,000	2,330	552	2,611	1,052	1,258	301
1915	3,767	2,161	1,041	565	3,531	2,161	1,088	282
1916	20,156	....	....	....	....	....	....	....

[a] Figures taken from Mineral Statistics of Great Britain and from India Geol. Survey Rec

[b] Locality not stated.

JAPAN.

Chromite was mined in Japan before 1907. The deposits were small and easy to mine and were therefore quickly exhausted. Chromite occurs in detrital deposits, in massive form in serpentine, and disseminated in irregular masses, many of which are large.

The mines worked prior to 1909 were the Wakamatsu, in Hoki Province; the Niimi and Takase, in Bitchu Province; and the Sasaguri and Mudagao, in Chikuzen Province. In 1909 and 1913 the Wakamatsu was the only mine worked. The ore averaged 40 per cent of chromic oxide (Cr_2O_3).

Chromite was discovered in Upper Mukawa, in Iburi Province, on Hokkaido Island, where the ore occurs both in massive form and as gravel in extensive areas of serpentine. Ores are also found in abundance on the boundary between the Provinces of Hoki and Bitchu, especially in Atetsu County, Bitchu.

Chromite produced in Japan, 1907–8, 1911–1918.[a]

[Quantities in long tons, 1907–8; in metric tons, 1911–1918.]

Year.	Hoki.	Bitchu.	Chikuzen.	Total.	
				Quantity.	Value (yen).
1907	1,475	768	47	2,290	
1908	2,004	420	20	2,444	
1911				1,524	2,107
1912				1,617	2,144
1913				1,329	1,364
1914				2,108	
1915				2,979	
1916				8,280	
1917				8,939	
1918				8,000	

[a] Figures for 1907 and 1908 taken from Mining in Japan, p. 98, Tokyo, Imperial Bur. Mines, 1909. Figures for 1911–1913 taken from Mining production for 1912, prepared by statistical division of Department of Agriculture and Commerce of Japan, and from Mining industry in Japan, Tokyo, Imp. Bur. Mines, 1915. Figures for 1914–1918 from table on p. 678.

BORNEO.

In 1892 Posewitz[1] reported the presence of an iron sand in Borneo in the diluvium, which contains chrome iron and magnetite. It is derived from the serpentine of the Riam Kiwa (or Riam Kina) and Riam Kanan, in southeastern Borneo,[2] from the syenitic rocks near Sukadana, in western Borneo;[3] and from the serpentines of Pulo Laut and of the neighboring Pagattan, on the southeastern extremity of Borneo. An analysis by Rest von Jonnigen[4] is as follows:

Analysis of chromite from Borneo.

Chromite	23.434
Oxide of iron	63.550
Sand	9.771
Alumina	2.987
	99.742
Loss on ignition	.258
	100.000

Chromite has been found on Malliwalli Island, British North Borneo,[5] and on Marasinsing Beach.

Analysis of chromite from Malliwalli Island, British North Borneo.[6]

Cr_2O_3	51.21
FeO	18.90
Al_2O_3	9.58
SiO_2	1.04
MgO	16.46

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[1] Posewitz, Theodor, Borneo, its geology and mineral resources, p. 431, 1892.

[2] Verbeek, R. D. M., Jaarboek van het mynwezen in Nederlandsch-Indië, 1875, vol. 1, p. 45.

[3] Everwyn, R., Idem, 1879, vol. 1, p. 59.

[4] Posewitz, Theodor, op. cit.

[5] Imp. Inst. Bull., vol. 8, p. 397, 1910.

[6] Analysis made in the scientific and technical department of the Imperial Institute: Imp. Inst. Bull., vol. 8, p. 397, 1910.

NEW CALEDONIA.

HISTORICAL SKETCH.

The presence of chromite as a universal constituent in the serpentine of New Caledonia was noted by Jules Garnier, civil engineer of the mines of New Caledonia, in 1866.[1] He mentioned the existence of chromite in a weathered serpentine on Mont d'Or, on the southeastern shore of Boulari Bay, near Noumea, and said that the chromite contained 42 per cent of chromic oxide (Cr_2O_3) and could be readily concentrated.

In 1876 Heurteau[2] stated that the firm of Delacrettaz et Cie., Havre, had valued the Mont d'Or material at 150 to 160 francs a ton, but that by a curious mistake a cargo of chromite which was shipped to them from Mont d'Or turned out to be iron ore and that after that error attempts to exploit the Mont d'Or material had lapsed.

The Mont d'Or beds, first exploited in 1875, were worked in 1887, and Garnier[3] said that the deposits on the southern slope of Mont d'Or easily ran as high as 50 per cent of chromic oxide. At that time the cost of delivery in a French or English port was 85 francs a ton, and the ore sold for 100 francs a ton. Garnier mentions beds of alluvial chromite in the southern part of the island near the Woodin Canal and said that the material ran over 40 per cent of chromic oxide and could be used for ferrochrome, though it was not rich enough for the bichromate industry. He calculated the cost of production at 25 francs a ton on board steamer.

In 1893 chromite was exported from New Caledonia but not in large quantities. The sources of supply were Mont d'Or, Baige N'Go, and Canoe Bay. Production did not materially increase until L. Bernheim formed the Société de chrome in 1902, with a capitalization of 3,800,000 francs. The bulk of the ore previous to the formation of this company had come from Baige N'Go, but in 1902 some mines were opened at Nehoue, in the Gomen district, on the northwestern coast. The Société de chrome was exploiting three main projects—the Mount Tiebaghi mines, in the northern part of the island, leased for three years to a company which was to mine a minimum of 10,000 tons on a royalty of 15 francs a ton; the South Bay mines, in the Plaine des Lacs; and the Plum mines, near the Bay of Prony.

Under the new management in 1903 the New Caledonian ores began to displace the Turkish ores, which had up to that time furnished one-half of the world's supply.

In 1911 the Chrome Co. (Ltd.) was formed with a capital of £190,000. It acquired from the Société de chrome the Tiebaghi mines and made an agreement with the Rhodesia Chrome Mines Co. (Ltd.) to market Rhodesia ores also.

A permanent outlet for the sale of New Caledonian ores was furnished by this company, and the New Caledonian and Rhodesian ores dominated the world's market until the outbreak of the war in 1914.

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[1] Garnier, Jules, Géologie de la Nouvelle Calédonie: Annales des mines, 6th ser., vol. 12, pp. 1-92, 1866.

[2] Heurteau, Émile, La constitution géologique et les richesses minérales de la Nouvelle Calédonie: Annales des mines, 7th ser., vol. 9, pp. 232-459, 1876.

[3] Garnier, Jules, Mémoires sur les gisements de cobalt, de chrome, et de fer à la Nouvelle Calédonie: Soc. ing. civils Mém., vol. 40, 1887.

OCCURRENCE OF CHROMITE.

Chromite is a remarkably constant constituent of the magnesian rocks of New Caledonia in the more or less serpentinized peridotites, in the red residual clays derived from serpentine, and also in the sands of the streams that drain the serpentine ridges.

Workable deposits of chromite occur as rock chrome and as the so-called alluvial deposits.

Rock chrome.—Chromite[1] occurs either in masses without a definite crystallization or in octahedrons scattered in a groundmass of serpentine and talc or of diallage (Tschaux mine) or olivine (Josephine mine, on Pirogue Bay). Rock chrome may occur in veins or in masses parallel to the strike of the serpentine. It is concentrated along the joints and in narrow beds. Most of it must be crushed before concentration, and only a few specimens can be hand picked.

Alluvial chromite.—The alluvial ores occur in decomposed rock and consist of granules of chromite in a red residual clay. Many of these granules are covered with a rusty coating, which is a residue of the original gangue mineral. The name "red chrome" is frequently used to denote this reddish ore.

As the chromite has not been transported, it is not alluvial in the correct sense of the word and might be termed saprolitic. In some places ore of this kind forms beds 30 feet in thickness. On account of its disintegrated character it is easily worked and concentrated by washing, so that it is a valuable source of chromium in spite of the fact that the actual content of chromic oxide is not so high as that of the underlying rock chrome. The ores run from 30 to 40 per cent of chromic oxide (Cr_2O_3) and can be concentrated to over 50 per cent.

MINING.

Tiebaghi mines.—The most productive source of chrome in New Caledonia is the Tiebaghi mines, which have furnished the largest quantity of ore exported from the island and also the richest grade of chromite. There are three workings, known as the Tiebaghi, the Old Mountain, and the Bellacoscia mines. They are located on the summit and slopes of Mount Tiebaghi, a serpentine massif which rises 1,800 feet above sea level.

The ore occurs both as alluvial ore and as rock chrome. The summit is covered with blocks of chrome 6 to 8 meters in length, strewn in a northeasterly direction for a distance of 100 meters.

The chromite appears to occur in a vein, but Glasser[2] in 1904 said that no effort had been made to exploit the mine by underground workings, and the depth of the vein could only be guessed. On the eastern slope a talus of chromite is composed of blocks varying in dimension from several hundred kilograms to the size of a nut. Alluvial chromite occurs in the red clay of the mountain slopes, is readily worked, and contains 50 to 55 per cent of chromic oxide (Cr_2O_3). The material is brought down by overhead cable, 200 tons a day, and loaded on a train which transports it 5 miles to punts, by which it is loaded on sloops in Nehoue Bay.

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[1] Glasser, M. E., Rapport sur les richesses minérales de la Nouvelle Calédonie, reprint from Annales des mines, second semester, 1903, and first semester, 1904.

[2] Glasser, M. E., op. cit.

East of the Tiebaghi mine, at the Old Mountain mine, alluvial chromite is worked. It affords, without concentrating, material that runs 52 to 54 per cent of chromic oxide. About 5,000 tons a year was taken out before 1904 and the ore was transported by oxcart to the coast.

The Moracchini mine is noted by Glasser as an unexploited working of chromite which is in line with the Tiebaghi mine.

The Bellacoscia mine, not far from the Old Mountain mine, shows alluvial chrome, in red clay. It seems probable, according to Glasser,[1] that here much of the chrome ore is derived from decomposition of rock chrome in place.

The total production of the Tiebaghi mines has been estimated at 4,000 to 5,000 tons a month.

Lucky Hit mine.—The second largest source of supply in the island is the Lucky Hit mine, 20 kilometers south of Noumea, near Plum. In 1880 this mine was the scene of the first active exploitation of chromite in New Caledonia. It contained a large quantity of alluvial ore and also some rock chrome, and in a few years furnished more than 10,000 tons of ore. The rock ore occurs in irregular masses in a groundmass of serpentine. This mine is the only one in which work has been carried on underground, but because of the irregular nature of the deposits the workings are very irregular. It is difficult to obtain chromite which runs as high as 50 per cent of chromic oxide (Cr_2O_3), and the greater part of the ore ranges from 30 to 40 per cent and requires concentration. In 1906 this mine produced 12,000 tons a year.

South Bay (Lakes Plain) mines.—Several mines around the Lakes Plain, near Prony, on South Bay, have been worked with more or less success. The serpentine of the southern part of the island is derived from a rock which varies from an almost pure olivine to an enstatite-olivine rock. All the summits surrounding the Lakes Plain are composed of serpentine. The plain itself consists of red clay that contains considerable chromite, which is not sufficiently concentrated, however, to be workable. Glasser [1] has noted a number of mines.

Chromite has been noted but not exploited successfully at the Muriel mine. The Anna Madeleine mine shows large blocks upon the summit of the hill, and also a talus slope of chromite. The ore runs 68 per cent of chromic oxide, according to Glasser.[1] (See table of analyses.)

The Tschaux mine shows a vein which strikes north and dips 45° W. Many tons had been taken out in 1904.[1]

The Bonne Veine mine shows a vein striking north and dipping 45° E., but the content of disseminated chromite in the rock is relatively small. Some alluvial chrome was worked.

N'Go Bay mines.—The mines at N'Go Bay, together with the Mont d'Or mine, were the chief source of production before the opening of the Tiebaghi mines.

The valleys of Pirogue and N'Go rivers are both particularly rich in alluvial chromite, and the Josephine and Red Chrome mines, in the Pirogue Valley, were once active sources of production, but when the alluvial chromite was exhausted the mines were abandoned without effort to exploit the rock ore. In 1913 [1] the Alice Louise mine was the only active mine along Pirogue River. It produced 30,000 tons of ore running 50 per cent of chromic oxide.

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[1] Glasser, M. E., op. cit.

On the N'Go River the July 14th mine shows an irregular bed of alluvial chromite 50 meters long and 40 meters broad. The chromite, which is very pure, contains little gangue and gives unconcentrated ore estimated at 54 to 55 per cent of chromic oxide.

The material worked at the Georges Piles mine consists of weathered blocks of chromite along the slopes of the mountain and grading into a trail 5 to 60 meters long of chromite weathered out of the serpentine matrix. By concentration this chromite can be raised to 55 per cent of chromic oxide. (See analyses.) It is concentrated in round buddles.

The Chromière mine near St. Vincent, is mentioned by Glasser[1] as in the serpentine massif of Mount Koungouari. The chromite ran about 52 per cent of chromic oxide (see analyses), but it was associated with much siliceous material, and concentration did not pay. It was mined about 1900.

The Belle Pluie mine was on the side of a mountain near Cape Goulvain. Ore which was nearly massive chromite, carrying 50 per cent of chromic oxide, lies in a vein with easterly strike, 1 meter wide. Transportation was difficult and the mine was exploited unsuccessfully in 1898–99 and in 1901.

The Espérance mine, in Poueo Valley, near Bourail, was not successful.

ANALYSES.

Analyses of chromite from New Caledonia.

	1	2	3	4	5	6	7	8	9	10
Cr_2O_3	55.70	54.50	42.60	41.80	61.333	61.533	68.00	58.10	52.00	55.54
FeO	13.20	17.70	......	......	......	......	17.79	27.60	29.10	14.50
Fe_2O_3	3.40	......	37.20	19.02	34.000	34.000	......	......	......	......
Al_2O_3	16.20	11.00	12.80	29.10	.114	.114	3.00	3.80	4.50	15.43
SiO_2	.20	3.10	1.20	2.10	4.625	4.625	......	5.10	4.20	1.30
MgO	9.80	8.00	5.10	5.10	.012	.028	11.10	3.20	8.60	12.85
CaO	.25	1.50	......	......	......	......	......	......	......	.80
MnO	.20	......	......	......	......	......	......	......	......	......
P_2O_5	.05	......	......	......	......	......	......	......	......	......
H_2O	1.05	......	1.10	3.40	......	......	......	......	......	......
Insoluble vesicle and loss	......	......	......	......	.016	......	......	......	......	......
	......	......	100.00	100.52	100.100	......	......	......	......	......

1. Steinhart, Metals and their ferro alloys: Inst. Min. and Met. Trans., vol. 15, p. 239, 1905–1906. Analyst, J. Clark, Glasgow. Locality of specimen not given.
2. The distribution and utilization of chrome ores, Imp. Inst. Bull., vol. 8, No. 4, p. 397, 1910.
3, 4. Garnier, Jules, Alluvial ores after concentration: Soc. ing. civils Mém., vol. 40, pp. 244–266, 1887.
5. Average of two analyses of chromite from Mont d'Or, one of which was made at the School of Mines at St. Étienne. Garnier, Jules, Annales des mines, 6th ser., vol. 12, p. 83, 1867.
6. Same analysis as No. 5 as reported by Garnier, Jules, Soc. ing. civils Mém., vol. 40, pp. 244–266, 1887.
7. Rock chrome from Anna Madeleine mine, South Bay. Glasser, M. E., Rapport sur les richesses minérales de la Nouvelle Calédonie, p. 318, Paris, 1904.
8. Alluvial chrome after concentration, Georges Piles mine, N'Go Bay. Idem.
9. Disseminated chromite from Chromière mine near St. Vincent. Idem.
10. Average composition of New Caledonia ore: Mineral Industry, vol. 4, p. 101, 1895.

CHROMIFEROUS IRON ORES.

Heurteau in 1876 noted the occurrence of chromium in the iron ores of New Caledonia. The chromiferous iron ores occur as residual deposits in the decomposed rock that overlies the serpentine hills.

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[1] Glasser, M. E., op. cit.

Analyses of chromiferous iron ores from New Caledonia.

	1	2	3
Peroxide of iron	69.60	73.00	68.00
Alumina	Trace.	....	1.10
Silica and titanic acid	5.60	7.60	SiO_2 15.20 TiO_2 .80
Red oxide of manganese	2.00	.60	2.08
Green oxide of chromium	5.33	2.85	2.00
Lime	Trace.	Trace.	.10
Magnesia	Trace.	Trace.	.10
Sodium chloride	Trace.	.40	....
Loss on ignition	16.60	14.30	10.20
Sulphuric acid	.60	.70	Trace.
Phosphoric acid	Not det.	Not det.	.06
	99.73	99.45	99.64

1, 2. Analyses made by Moissenet and quoted by Heurteau, Les richesses minérales de la Nouvelle Calédonie: Annales des mines, vol. 9, 7th ser., p. 386, 1876.

3. Analysis of an average sample by Garnier at the St. Nazaire blast furnace laboratory, Mémoire sur les gisements de cobalt, de chrome, et de fer à la Nouvelle Calédonie, p. 23, Paris, 1887.

PRODUCTION.

Chromite produced in and exported from New Caledonia, 1886–1918.

Year.	Production (metric tons).		Exports.		
			Quantity (metric tons).	Value.	
	1[a]	2[b]		Francs.[a]	Pounds.[b]
1886	1,800	....	....	....	....
1887	2,500	....	....	....	....
1888	....	....	....	....	....
1889	2,300	2,254	....	....	....
1890	3,825	....	....	....	....
1891	4,343	....	....	....	....
1892	500	512	....	....	....
1893	240	242	....	....	....
1894	[c]2,900	2,927	1,042	175,620	....
1895	[c]8,079	....	8,014	444,345	....
1896	20,200	20,186	16,018	1,111,000	....
1897	[d]3,050	3,949	9,054	200,000	....
1898	[d]14,300	....	14,300	715,000	....
1899	12,600	12,634	12,480	644,000	....
1900	....	10,500	10,474	630,000	....
1901	17,500	17,451	16,586	946,000	....
1902	10,300	10,281	10,281	463,000	....
1903	[e]21,400	21,437	21,400	1,124,000	....
1904	....	47,247	[f]42,197	3,082,000	....
1905	....	76,933	51,374	[b]2,008,000	153,860
1906	....	84,241	[f]84,200	368,000	156,680
1907	3,800	....	25,371	361,000	22,440
1908	15,800	....	46,890	501,000	23,640
1909	40,000	....	32,136	1,080,000	43,200
1910	40,000	....	28,444	1,080,000	43,200
1911	82,806	35,000	82,806	....	37,800
1912	42,000	....	51,516	....	50,480
1913	63,370	....	63,370	....	....
1914	71,708	....	42,000	....	....
1915	57,474	....	67,000	....	....
1916	57,024	....	....	....	....
1917	41,892	....	....	....	....
1918	26,000	....	....	....	....

[a] Statistique minérale de France (original source).
[b] Mineral statistics of Great Britain.
[c] 50 per cent ore.
[d] 51 per cent ore.
[e] 50 to 56 per cent ore.
[f] Probably represents production wrongly listed as exports.

SUMMARY.

The principal chromite ore workings in New Caledonia are in the northern part of the island, on Mount Tiebaghi. The second largest source of chromite is on Plum Bay, in the southwestern part of the island. A considerable quantity of ore has been derived from the Lakes Plain mines, on South Bay, at the south end of the island.

The ore occurs both as rock chrome, usually as spotted ore, more rarely massive, and as alluvial chromite. The alluvial ores range from 30 to 40 per cent of chromic oxide and are concentrated to about 50 per cent. The rock chrome is estimated to contain an average of 55 per cent of chromic oxide and some specimens show 61 per cent. Silica ranges from 0.2 to 5.10 per cent.

Chromite was discovered in New Caledonia in 1866 by Jules Garnier. The deposits were first exploited in 1875 at Mont d'Or near Noumea, and up to 1903 the annual production had not amounted to 20,000 tons, except in 1896. After 1903 the New Caledonia chromite displaced the Turkish ores and furnished most of the world's supply. The maximum production recorded was 84,241 metric tons, in 1906. The last recorded production was 26,000 metric tons in 1918. The development of New Caledonia ores is controlled by the Chrome Co. (Ltd.), which was formed in 1911 from the French Société de chrome, organized in 1902.

AUSTRALIA.

The States in Australia that have produced chromite in commercial quantities are New South Wales and Queensland. Deposits of chrome have also been noted in Western Australia, Victoria, and Tasmania.

NEW SOUTH WALES.

Chromite was first discovered and mined in New South Wales in 1882. After vigorous prospecting during 10 years the ore had been found at over 60 different localities. The production became increasingly important after 1893, the maximum recorded being in 1899. The principal deposits occur in post-Devonian serpentine intrusions in two localities—in the New England Mountains, about 200 miles north of Sydney, and in the northern extension of the Snowy Range, about 200 miles southwest of Sydney.

NEW ENGLAND MOUNTAINS.

The area in the New England Mountains was the site of the earliest mines worked in New South Wales. Chromite was mined in 1882 near Nundle, on Peel River. The ore, which occurs in a vein 40 feet thick upon a high range about 1 mile northeast of Bowling Alley Point and about 700 feet above the level of the point, carries from 37 [1] to 64 [2] per cent of chromic oxide (Cr_2O_3).

In 1891 outcrops of chromite at Gordonbrook, in the Clarence River district, were investigated by David.[3] The ore occurs in the parish of Pucka, 30 miles northwest of Grafton, at Oaky and Fine Flour Creeks. David estimated a yield of approximately 20,000 tons to a depth of 90 feet. The ore ranges from 28 to 55 per cent of chromic oxide. It fills pockets in serpentine in two principal groups. In one group the two largest pockets measured 12 by 14 feet and 24 by 18 feet. In one bunch the ore is disseminated through the serpentine and requires dressing. The larger of the two pockets in the other group measured 90 by 36 feet, and the ore was of better quality than that occurring in the first group. About 30 tons was mined in 1891 and 1892, but the ore had to be hauled 24 miles to Clarence River, and the transportation problem caused the abandonment of the workings.

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[1] Imp. Inst. Bull., vol. 8, p. 395, 1910.
[2] Liversidge, A., Minerals of New South Wales, p. 106, 1888.
[3] New South Wales Dept. Mines and Agr. Ann. Rept. for 1891, p. 218.

Chromite was discovered in 1891 at Spring Creek, about 3 miles southeast of Bingara, by David,[1] who reported that ore assaying 40 to 41 per cent of chromic oxide occurred in segregated masses, some measuring 7 by 6 feet, in a serpentine dike. In 1904, 20 tons of this ore was sold at a good profit, and it was reported that mines would probably be opened there. The ore was worked for three years and used for furnace linings.

Ore from the Barraba district was assayed in 1888 and 1895 and showed a content of 40 to 44 per cent of chromic oxide. It was worked in 1911, 1913, 1914, and produced a total of about 3,150 tons, which exhausted the supply.

At Port Macquarie a natural concentration of chromite sand [2] contained 48.24 per cent of chromium sesquioxide and 1.29 per cent of cobalt protoxide. The deposit does not appear to have been worked.

Chromite assaying 40.41 to 46.59 per cent of chromic oxide has been reported from a serpentine intrusive in the Tamworth district, between Attung and Manilla.[2]

SNOWY RANGE.

The area of chrome deposits that has produced most of the ore mined in New South Wales in recent years is in the Gundagai-Tamut district, on the western slope of the northern extension of the Snowy Range, about 200 miles southwest of Sydney, where irregular deposits are found for a distance of 10 to 12 miles. The first mine in this district, known as the Wrights or Vulcan mine, was opened in 1892 on the Mooney Mooney Range, 4 miles northeast of Coolac, in Gobarralong. In 1894–95 it produced about 2,000 tons. Samples of ore assayed 47.68 to 48 per cent of chromic oxide [2] (Cr_2O_3).

Shortly after the opening of the Coolac mine another group was opened in Buccleugh County on the slopes of Mount Lightning, about 18 miles above Gundagai on Gundagai River. The mines on the north slope were the Quilters mines, and those on the south slope the Mount Mary mines, at Adgungbithy Creek. The ore at the Quilters or Helena mine was worked first by an open cut and later by shafts. It carried from 49 to 58 per cent of chromic oxide. In 1896 this deposit was estimated by William Adams, jr., to contain 20,000 tons of ore averaging 50 per cent of chromic oxide.[3] The Mount Mary mine produced ore having a content of 48 to 49 per cent of chromic oxide. The ore occurred in pockets.

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[1] New South Wales Dept. Mines and Agr. Ann. Rept. for 1891, p. 235.

[2] Carne, J. E., Notes on chromic iron ore: New South Wales Dept. Mines Ann. Rept. for 1897, p. 150.

[3] Mineral Industry, vol. 6, p. 150, 1897.

Other mines in Buccleugh County are along the southern extension of the Honeysuckle Range, whose northern termination is Mount Lightning. They are, from north to south, the Welch, Kangaroo, Emu, Mount Miller, Keefe, and McInerny mines. The Mount Lightning mines were opened in 1893. During 1898 and 1899 they were the only mines worked in New South Wales and they produced during those two years 7,354 tons. The production for 1899 represented the maximum annual production. They were practically the only source of production of chromite in New South Wales until 1904, when ore was exported from Bingara. That year the production at the Mount Lightning mines decreased, owing to the low grade of the ores, which carried less than 46 per cent of chromic oxide.

ASSAYS.

Assays of chromite from New South Wales.[1]

	Per cent of chromic oxide.
Northern district:	
Bowling Alley Point	37–64
Clarence River	28–55
Bingara district	40–41
Barraba district	40–44
Port Macquarie	48.24
Tamworth district	40.41–46.59
Southern or Gundagai-Tamut mining district:	
Vulcan mine	47.68–48
Quilters mine	49.8–56.5
Mount Mary mine	48–49
Kangaroo mine	53–57
Mount Miller mine	48.13

VICTORIA.

Chromite has been found in Victoria in the serpentine area of Wellington River, Gippland, on the southeastern flanks of the Australian Alps. The ore, which occurs in masses weighing hundreds of pounds, has been found over several acres but does not appear to be available at present, owing to poor facilities for transportation.

TASMANIA.

Chromite has not been mined in Tasmania, but it occurs in the North Dundas tin placers of Pieman River. A chromiferous hematite, which lies on the surface of a large mass of serpentine carrying thin veins of asbestos and magnetite at the Ironstone Hills, near Tamar River, at Port Lampiere, contains about 3 per cent of chromic oxide and a little sulphur and phosphorus. It was estimated that this deposit contains about 500,000 tons of ore in boulders. The ore was smelted in 1872 by the Tasmanian Coal & Charcoal Co., at Ilfracombe, near Launcestown, and several tons of white pig iron containing 6 to 7 per cent of chromium was shipped to the United Kingdom. The company failed because pig iron containing chromium could not be marketed in the colonies.[2] The mines were again prospected about 1892, but there is no evidence of further activity. The ore was valued in 1893 at 5 shillings a ton at the mines and 15 to 20 shillings in any English port.

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[1] New South Wales Dept. Mines Ann. Rept. for 1897, pp. 148-150.

[2] Hadfield, R. A., Alloys of iron and chromium: Iron and Steel Inst. Jour., 1892, No. 2, p. 67.

QUEENSLAND.

Chromite float was discovered by C. S. A. Drain[1] in 1900 about half a mile north of Cawarral Township, Queensland. A deposit was located by prospecting, and the Elgalla mine was opened near Rockhampton. Considerable chromite has been taken from this mine and used in the manufacture of fire bricks. In 1906 Bale[2] reported that he had inspected occurrences of chromite at Kilkivan and found insignificant outcrops of ore in bunches in decomposed serpentine. The material analyzed 30.6 per cent of chromic oxide and 13.9 per cent of oxide of iron (FeO). A small quantity was mined in 1907 at Tooker's Hill. Boulders are reported to occur at Pine Mount, Ipswich, but the quantity is not known. The ore is massive, both amorphous and crystalline, and contains, according to Macivor,[3] 42 to 60 per cent of chromic oxide. In 1893[4] it was stated that the report of a discovery near Ispwich had no foundation in fact. Most of the chromite produced in Queensland has come from the Elgalla mine, in the Rockhampton district.

Chromite sold in Queensland, 1907–1918.

Year.	Quantity (long tons.)	Locality.	Value.
1907	[a] 84	Tookers Hill	
1908	184	Rockhampton district	
1909	260	Elgalla mine	£190
1910	873	Elgalla mine (773 tons) Balnagowan mine (100 tons)	581 150
1911	Little.	Elgalla mine; Balnagowan mine in Broadmount.	
1912	450	Elgalla mine	413
1913	177	do	177
1915	129	Rockhampton	
1916	[b] 36	Rockhampton district	54
1917	[c] 756	Cawarral Elgalla (6 tons)	756
1918	232	Cawarral	268

[a] Concentrates from 105 long tons of crude ore.
[b] Production, 160 tons.
[c] Production, 830 tons.

WESTERN AUSTRALIA.

Chromiferous iron ore occurs at Comet Vale, North Coolgardie, Western Australia. (See analysis, below). No chromite is produced.

ANALYSES.

Analysis of chromite from Australia.[5]

Cr_2O_3	33.20
FeO	23.40
MgO	17.40
Al_2O_3	18.00
SiO_2	8.00
	100.00

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[1] Queensland Under Secretary for Mines Ann. Rept. for 1900, p. 121, 1901.
[2] Idem for 1906, p. 170, 1907.
[3] Macivor, Emerson, Occurrences of chrome iron ore in Australasia: Chem. News, vol. 57, p. 2, 1888.
[4] Mineral Industry, vol. 3, p. 122, 1894.
[5] Analysis by A. Clouet, quoted in Iron and Steel Inst. Jour., 1886, No. 2, p. 809.

Analyses of chromiferous iron ore from Australia.

	1	2	3
Fe_2O_3	79.01		
FeO		42.5	80.0
Cr_2O_3	5.30	3.0	3.4
Al_2O_3		15.3	5.8
SiO_2	3.14	18.4	4.8
P	.078		
S	.124		
Volatile on ignition		19.5	5.1
Difference		1.3	.9
		100.0	100.0

1 Ore from Comet Vale, North Coolgardie. Mineral Industry, vol. 20, p. 127, 1911.
2, 3. Ores from Ilfracombe, Tasmania. Woodgate, analyst, 1880. Iron and Steel Inst. Jour., 1892, No. 2, p. 66.

Analysis of white pig iron produced by Tasmanian Coal & Charcoal Co. from Ilfracombe ores.[1]

Carbon	4.42
Silicon	1.52
Sulphur	.10
Phosphorus	.05
Manganese	.14
Chromium	7.05
Iron	86.56
	99.84

SUMMARY.

In Australia, New South Wales has been the chief producer of chromite. Ore was discovered there in 1882 and has been exported steadily every year since 1894, except in 1909, when there was no market. The chromic oxide content of the ore is variable, ranging from 33 to 64 per cent. The maximum quantity exported in a single year was 5,243 long tons in 1899. The last recorded production was 450 long tons in 1916. Queensland has exported a few tons annually since 1907. The ore has been concentrated and is used in the manufacture of fire bricks.

NEW ZEALAND.

No chromite has been exported from New Zealand since 1902, and the total output of ore is not large. The only reported deposits of chromite are in South Island, where chromite occurs in the Nelson district, in Westland, and in Otago. Ore has been exported from the Nelson district.

NELSON DISTRICT.

Chromite is associated with the Dun Mountain[2] "mineral belt," a sheet of serpentine and dunite that extends in a southwesterly direction about 60 miles from D'Urville Island to Little Ben Nevis Mountain, near the gorge of Wairoa River. The chief chromite mines extend over a distance of 12 miles between the Upper Maitai Valley and Lea River. The greater part of the ore exported came from Dun Mountain, which is composed of dunite containing chromite in both the massive and the disseminated varieties. The dunite, which is intruded into a Carboniferous limestone series, is surrounded by a belt of serpentine about half a mile wide. The workable deposits of chromite occur in this serpentine belt. In a working of the Dun Mountain Copper Co., a 10-foot band of chromite was reported. Some of the dunite contained as much as 50 per cent of chromite, carrying as high as 55 per cent of chromic oxide (Cr_2O_3). A working of the Roding River Copper Co. showed a band of ore more than 15 feet wide and 300 to 400 feet deep. The ore was worked by open cuts on the summit of Little Ben Nevis. Massive crystalline ore occurred in pockets or vertical seams, the largest of which contained as much as 68 tons of ore. Amorphous massive chromite formed horizontal lodes. The disseminated ore varied in grade from 22 to 90 per cent of chromite and averaged 64 per cent of chromic oxide (Cr_2O_3). There appears to have been only a small output from this source. A little ore was exported in 1901–2 from Onatea, on the south side of Croixelles Harbor. The ore occurred in elliptical masses about 1,200 feet above sea level, but the deposits proved to be only of limited extent.

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[1] Iron and Steel Inst. Jour., 1892, No. 2, p. 65.
[2] Distribution and utilization of chromium ores: Imp. Inst. Bull., vol. 8, p. 396, 1910.

WESTLAND.

Chromite has been reported to occur near Jackson Bay, in southern Westland.

OTAGO.

Chromite has been found in northwestern Otago abundantly disseminated at Milford Sound, in the Lake Harris range, in the serpentine of the Red Hills, intruded into Devonian strata, and also at Moke Creek. There is no evidence that this chromite has proved of commercial value.

ANALYSES.

The following assays of ore from the Dun Mountain mineral belt are given by Macivor:[1]

Chromic oxide content of ore from Dun Mountain belt, New Zealand.

	Aniseed Valley.	Adams Lode.	Maungatapa.	Croixelles.	Little Ben Nevis.
Crystalline massive	52. 56	57–65	53–64		55–62
Amorphous massive	42–51		30–50	40–46	
Nodular	56–69				59. 8–68. 9

PRODUCTION.

Up to 1866 the total production of chromite in New Zealand, as represented by exports, was 5,666 tons, valued at £37,367.[2] The maximum production for one year was 3,843 tons, valued at £24,719, in 1862. From 1866 to 1901 no exports were recorded.[3] In 1901[4]

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[1] Macivor, Emerson, Occurrences of chrome iron ore in Australia: Chem. News, vol. 57, p. 1, 1888.

[2] Imp. Inst. Bull., vol. 8, p. 396, 1910.

[3] George J. Binns (Fed. Inst. Min. Eng. Trans., vol. 4, p. 68, 1893) contends that the statement made in the report of the Mines Department that the chrome industry became extinct in New Zealand in 1866 is scarcely correct. He bases his contention on references to New Zealand Geol. Survey Rept. for 1881, p. 7.

[4] Mineral Industry for 1901, vol. 10, p. 98, 1901.

28 tons, valued at £110, was produced at Onatea, Nelson. In 1902 175 tons was shipped from Onatea, and since then export production has ceased.

Chromite exported from New Zealand, 1858–1866, 1901–1902.[a]

Year.	Quantity (long tons).	Value.
1858	3	£25
1859	8	120
1860	116	1,440
1861	52	520
1862	3,843	24,719
1863	595	4,318
1864	768	4,910
1865	....	....
1866	281	1,315
1901	28	110
1902	175	525

[a] New Zealand Mines Dept., Papers and reports relating to minerals and mining in New Zealand.

DOMINICAN REPUBLIC.

In 1821 Prof. Vitales sent to Berthier[1] a sample of chromite from Ile à Vaches, 17 kilometers south of Santo Domingo. The chromite occurred in small octohedral grains in a chrome sand deposit, about 33 meters long, at the mouth of a little valley. The sand, composed of chromite, quartz, calcareous material, and titaniferous iron, is deposited in beds 2 to 3 centimeters thick. It would appear that Berthier worked with this material from Ile à Vaches during his researches on ferrochrome in 1820.[2]

Analyses of chromite from Ile à Vaches, Dominican Republic.

	1a.	1b.	2.
Cr_2O_3	36.0	36.0	51.53
FeO	37.0	37.2	48.46
Al_2O_3	21.5	21.8	.00
SiO_2	5.0	5.0	.00
	99.5	100.0	99.99

1a. Analysis of unconcentrated ore including gangue made by Berthier, Annales des mines, 1st ser., vol. 6, p. 573, 1821.
1b. Apparently same analysis but slightly different figures quoted by Boussingault in Iron and Steel Inst. Jour., 1886, No. 2, p. 810.
2. Analysis made by A. Clouet on octahedral grains obtained by concentration, quoted in Iron and Steel Inst. Jour., 1886, No. 2, p. 809.

It was reported in 1906–1908[3] that nickel, cobalt, and chromium had recently been discovered in Santo Domingo.

COLOMBIA.

Boussingault[4] reports that chromite occurs in such abundance near Antioquia, Colombia, that the angles of the walls of the houses were built of it.

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[1] Annales des mines, 1st ser., vol. 6, p. 573, 1821.
[2] Annales chim. phys., 2d ser., vol. 18.
[3] Mineral statistics for Great Britain for 1906, 1907, 1908.
[4] A note on the production, constitution, and properties of chrome steel: Annales chim. phys., 5th ser., vol. 15.

The following is a translation of Boussingault's paper:[1]

Before the year 1867 a company erected a forge in the neighborhood of Medellin, in the Province of Antioquia, in South America, where a brown ore resembling hematite was treated, French workmen performing the work. The metal produced was specially employed for making stamp heads for crushing auriferous quartz—a use for which it was exceptionally well adapted on account of its hardness; and notwithstanding its high price, it was much in demand. Its quality suggested the presence of chromium, and this can easily be explained, as I observed, during my stay in Antioquia, that chromium ore exists in abundance in the land on which the works were built—to such an extent, indeed, that the angles of the walls of the houses were built of chromium ore. The Medellin pig iron examined in my laboratory was white and presented all the characteristics of spiegeleisen. Analysis gave the following results:

Chromium	1.95
Combined carbon	4.40
Graphite	.00
Silicon	.75
Phosphorus	.07
Sulphur	Trace.
Arsenic	.00
Nitrogen	.01
Vanadium	Trace.
Manganese	.84
Iron	92.50
	100.52

Other analyses gave 2.80 and 3.80 per cent of chromium. It is then evident that chrome iron was produced from the South American blast furnaces during the years 1866–67, long before it was produced in the same way at Brooklyn. Its production, therefore, had become public property. Superior richness in chromium, resulting from the fact that the charges passed into the furnace contained larger proportions of chromium ore, is hardly sufficient grounds for a patent.

CHROMITE AND CHROMIFEROUS IRON ORE IN CUBA.

By E. F. Burchard.

CHROMITE.

The chromite deposits of Cuba were examined by the writer, in company with Albert Burch, of the Bureau of Mines, in the Spring of 1918, and are described in greater detail elsewhere.[2]

DISTRIBUTION OF DEPOSITS.

The deposits of chromite in Cuba that have thus far attracted attention are within 25 miles and most of them within 10 miles of the north coast. There are about twelve groups of deposits, which display considerable diversity in quality, size, and accessibility. One of the most westerly deposits is in the eastern part of the Province of Havana, and two are in the Province of Matanzas. The next group toward the east is in the Province of Camaguey, a few miles northeast of the city of Camaguey. Other groups of deposits are in the Province of Oriente, one near Holguin and another south of Nipe Bay, and there are three groups in the mountains near the coast between Punta Gorda and Baracoa.

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[1] Iron and Steel Inst. Jour., 1886, No. 2, pp. 813, 814.

[2] Burchard, E. F., Chrome-ore deposits in Cuba: Am. Inst. Min. and Met. Eng. Bull. 153, pp. 2523-2546, September, 1919.

GEOLOGIC AND TOPOGRAPHIC FEATURES.

Areas of serpentinized basic rocks occur in all the Provinces of Cuba, generally parallel to and within a few miles of the north coast. Within these masses of serpentine are segregated bodies of chromite. Fibrous spots resembling asbestos commonly occur in the serpentine near the ore bodies. The deposits are lenticular and tabular masses ranging in thickness from 1 foot to more than 50 feet and reaching a maximum length of more than 200 feet, but they may include small masses of serpentinized peridotite. Stringers of chromite branch out, especially near the ends of the larger bodies.

Thin veinlike seams of ore have also been noted. The ore bodies appear to be characteristic magmatic segregation deposits and resemble many of those found in areas of serpentine in California and Oregon.

Most of the mineralized masses are highly inclined, and certain of them that are exposed in ravines on steep hillsides in mountainous or hilly regions dip at about the same angle as the hillsides. The deposits west of Nipe Bay are in areas of moderate relief; those near Camaguey are in an area of very low relief. The deposits in the eastern part of Oriente Province, which are the largest, are in mountainous country and are very difficult of access. The serpentine areas are characterized by thin, poor soils, lacking in potash, and support only a scant vegetable growth consisting chiefly of low scrub palm, coarse grasses, and thorny weeds.

The ore is generally fine grained to medium coarse grained and varies from spotted material consisting of black grains of chromite, ranging in diameter from a thirtieth to a quarter of an inch, embedded in white or light-green serpentine, to compact black granular material containing little or no visible serpentine. Fine seams of a green crystalline mineral, uvarovite, a calcium-chromium garnet, are occasionally found in the ore. As a rule, the grade of the ore is not high. Excellent specimens may be procured at almost all deposits and picked up in the float, but it would require highly selective mining at most places to yield a product that would average 45 per cent chromic oxide.

The mineral chromite ($FeO.Cr_2O_3$), free from impurities, contains, theoretically, 46.66 per cent chromium, or 68 per cent chromic oxide. Representative samples from 18 deposits gave chromic oxide 26 to 43 per cent; iron 10 to 13 per cent; silica 1 to 12.5 per cent; alumina 15 to 33 per cent. Traces of sulphur, phosphorus, and nickel were found in some of the samples, but others contained none. The majority of the samples carried between 33 and 40 per cent of chromic oxide (representing between 22 and 27 per cent of chromium), and only two carried more than 40 per cent chromic oxide. Ores of certain other deposits, reliable analyses of which are available, are of better grade, some of them showing as high as 48 per cent chromic oxide and as little as 8 per cent of iron. In most of the ores of which analyses are available the percentage of chromium is two or more times that of the iron, a relation of importance in connection with the manufacture of ferrochrome in the electric furnace.[1]

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[1] Keeney, R. M., Manufacture of ferroalloys in the electric furnace: Am. Inst. Min. Eng. Bull. 140, pp. 1323-1332, August, 1918.

HABANA AND MATANZAS PROVINCES.

In the eastern part of Habana Province small pockets of chromite have been found at a point about 2 miles south of the village of Canasi, 10 miles from the railroad. A little mining has been done here on the Elena claim, from which, it is reported, about 600 tons of ore has been shipped. In Matanzas Province small deposits of ore have been found on the Jack claim, about 7 miles northwest of the railroad station of Mocha, and on the Ana Maria claim, about 10 miles west of Cardenas. This claim is only 2 miles from a railroad, but no ore had been shipped from it at the time it was visited by the writer. Considerable development work has been done on the Jack claim and there was a total stock of about 450 tons of ore on hand in February, 1918.

An analysis by R. C. Wells, of the United States Geological Survey, of a composite sample of ore taken from two bins at this mine gave the results shown under 1 in the following table, and analyses A and B, made by Ricketts & Co., of New York, represent samples obtained by trenching separately the two bins of ore:

Analyses of chromite from stock at Jack mine, near Matanzas.

	1	A.	B.
Cr_2O_3	43.0	36.52	35.84
Fe	13.0	12.3	11.85
SiO_2	5.4	6.66	6.73
Al_2O_3	15.0	....	....
S	Trace.	....	....
P	None.	.04	.03
Ni	Present.	....	....

Probably no great quantity of ore can be shipped in the near future from any of these deposits. The geologic conditions in these areas, however, warrant further explorations.

CAMAGUEY PROVINCE.

The deposits of chromite examined in Camaguey Province consist of three groups, which lie along a narrow zone beginning about 9 miles northeast of the city of Camaguey and extending southeastward to a point near the Camaguey & Nuevitas Railroad, 2 miles northeast of Alta Gracia station. Immediately north of Camaguey there is a nearly level plain, which extends northward for several miles and is covered with a thin mantle of ferruginous clay and limonite gravel. The deposits lie along the border of this plain, at its junction with some low hills that are outliers of a plateau south of the Cubitas Mountains, so that they are easily accessible by wagon roads. The local rock is serpentine, with masses of gabbro cropping out on the hills. Float fragments of ore are scattered throughout this zone, and there are about fifteen places where chromite float is so thick as to suggest that small bodies of ore in place may be obscured by broken ore or rock débris. Broken ore caps ten or twelve small mounds that rise 5 to 50 feet above the surrounding surface. The claims known as the Teire, Leocadia, and Ninas are near the west end of the zone, one near the middle of the zone is the Nona, and the easternmost one is the Victoria. Prospecting has been done here to obtain samples of ore for analysis, but it has not shown the nature or extent of the deposits in place. On the surface, however, there was observed a considerable quantity of ore in the form of broken blocks and coarse float, probably 20,000 tons, and if the deposits have not been completely eroded there may be as much more ore in place below the surface. The ore is not of uniform grade. Some is fine grained and compact, but the greater part is medium to coarse grained. A small part of the ore consists of granular chromite containing little or no foreign material, but the greater part is "spotted" ore—that is, ore consisting of grains of chromite embedded in a gangue of light-green to white serpentine.

Ten samples of ore from deposits near Camaguey contained 27 to 36 per cent of chromic oxide (Cr_2O_3), as shown by analyses by R. C. Wells, tabulated below. Only two of these samples contained less than 30 per cent and few contained more than 35 per cent. The ore in these deposits is therefore of low grade, but it may be suitable for certain purposes. If it should require concentration, sufficient water is believed to be available in small streams within a mile of the deposits.

Analyses of chromite from deposits near Camaguey.

	9	10	11	12	13
Cr_2O_3	33.7	33.7	33.8	35.2	36.3
Fe	12.2	12.3	10.9	11.8	10.6
SiO_2	3.9	4.3	4.1	3.9	3.6
Al_2O_3	29.8	30.7	27.0	27.4	26.2

	14	15	16	17	18
Cr_2O_3	35.0	27.4	29.1	34.2	34.1
Fe	11.6	10.7	11.4	11.1	11.0
SiO_2	4.5	4.0	2.4	1.5	1.5
Al_2O_3	26.7	30.2	32.9	28.3	28.7
S				None.	
P				Trace.	
Ni				±0.05	

Samples 9–11 from the Teire, Leocadia, and Ninas claims, north-northeast of Camaguey; 12–16 from the Nona and an unnamed deposit northeast of Camaguey; 17–18 from the Victoria claim, northeast of Alta Gracia.

As these deposits can be reached by wagon roads that are already in existence or that might be laid out over nearly level ground they are of interest, notwithstanding the low grade of the ore.

Besides the chromite deposits examined by the writer in the vicinity of Camaguey others are situated about 20 miles north of Camaguey and just north of the east end of the Cubitas field of surficial brown iron ore. In this locality claims known as the Cid, Teyde, and Yunque, which were examined by A. C. Spencer, of the United States Geological Survey in 1907, all show noteworthy quantities of chrome float, apparently of good grade, and the occurrence of tabular bodies of ore from 1 to 5 feet wide is indicated. On the Cid claim boulders of ore are distributed over a belt about 1,700 feet long, and on the Yunque the ore fragments are found in an area 150 by 250 feet. On the Teyde five separate deposits lie within an area measuring 1,200 by 3,000 feet. These deposits, one of which seems to be continuous for 900 feet, strike N. 10°–30° E.

ORIENTE PROVINCE.

Small deposits of chromite occur on the Maria del Carmen claim, 7 to 8 miles northeast of Holguin, on the northwest slope of a low ridge of serpentine that lies between two higher ridges of steeply inclined limestone which stand about half a mile distant to the northwest and the southeast. Several prospects have been dug, and one pocket has yielded about 150 tons of ore, which, with 25 tons of float that has been gathered, was ready for shipment in March, 1918. Analysis showed that some of the ore contained from 30.6 to 34.37 per cent of chromic oxide.

One of the larger deposits of chromite, the one that gave greatest promise of producing a considerable output in 1918 and 1919, is on the Caledonia claim, which is on the southern slope of the Sierra de Nipe, about 8 miles southeast of Woodfred, the headquarters of the Spanish American Iron Co.'s Mayari iron mines. The upper part of the ore body crops out of serpentine on a steep hillside southeast of and about 300 feet above a mountain stream that flows into the Pinos, a small tributary of Mayari River. The ore body is roughly tabular in form, and, as shown by prospect trenches dug on the outcrop, is 10 to 30 feet thick. It dips toward the northwest at about the slope of the hillside (40° to 45°), and where it does not crop out it lies 30 to 50 feet from the surface. Two tunnels cut the ore at levels 100 feet and 200 feet below the top outcrop, and though the body has not been fully explored along the strike or in depth it may average 20 feet in thickness and may extend 200 feet along the strike and to a depth of 200 feet. This ore body lies so close to the surface of the hillside that it possibly may be mined by an open cut.

The ore varies in quality, the better grade being in the western part of the deposit, where it carries as high as 48 per cent of chromic oxide. Analyses furnished by the Spanish American Iron Co. show a range of 35 to 48 per cent of chromic oxide, 7 per cent to 15 per cent of silica, and 7.7 to 10 per cent of iron for the whole body. By cobbing or by simple water concentration it may be possible to maintain a shipping grade of ore containing 44.5 per cent of chromic oxide. The deposit has been estimated by the company engineers to contain about 50,000 tons of chromite, 25,000 tons of which should carry more than 40 per cent of chromic oxide and the remaining 25,000 tons between 34 and 40 per cent. By rough concentration, for which abundant water is available in the creek, this low-grade ore should yield 15,000 tons of concentrates carrying about 40 per cent of chromic oxide, so that about 40,000 tons of ore of this grade should be available.

A zigzag trail of easy grade, descending 1,000 feet in 3½ miles, has been cut from the plateau down to the deposit. In March, 1918, some ore was packed out on mules to the top of the trail, from which it was carried 4½ miles by autotruck to the railroad at the Mayari iron mines. Routes had been surveyed and cleared for an aerial tramway 6,000 feet long, which would make it possible to increase greatly the rate of production.

The Cayoguan group of chromite claims, which include the Cayoguan, the Narciso, and the Cromita Nos. 1, 2, and 3, are on both sides of the Rio Cayoguan about 5 miles above its mouth, which is in Moa Bay. The Cayoguan claim is on the right side of the river about 600 feet above it and about 750 feet above sea level. An area that extends around the hillside for about 300 feet horizontally, with a vertical height of perhaps 20 feet, has been prospected by means of a few small cuts, which disclose massive chromite, generally of good appearance where freshly exposed. What appeared to be a fair sample of the ore contained 38.1 per cent of chromic oxide.

The Narciso claim, which nearly surrounds the Cayoguan, includes, at a distance of about 600 feet south of the Cayoguan, an ore body that crops out on a steep hillside about 500 feet above the river. A sample of ore from this outcrop showed on analysis 34.8 per cent of chromic oxide.

The Cromita claims, on the left side of the river, contain three known ore bodies and hundreds of tons of boulder float ore in an arroyo. The ore bodies are exposed in the river bluff at a height of 150 to 300 feet above the river. The most northerly ore body shows a face 20 feet wide and 15 feet high and has been prospected by an open cut. A sample taken from this cut contained 31.9 per cent of chromic oxide. The middle body, which includes an outcrop 75 feet long and 50 feet high, has been penetrated 35 feet by a cut and a tunnel. A sample from the fines of the tunnel dump carried 25.9 per cent of chromic oxide. The southerly ore body is exposed to a length of about 60 feet and a height of about 40 feet. Its thickness had not been determined. A sample from the outcrop contained 40.5 per cent of chromic oxide. The geologic conditions indicate that the middle and southern bodies, whose outcrops are about 75 feet apart, may possibly be connected within the hill. The following analyses by R. C. Wells show the general composition of the ore in this locality:

Analyses of chromite from the Cayoguan group of claims, near Moa Bay.

	2	3	4	5	6
Cr_2O_3	38.1	34.8	31.9	25.9	40.5
Fe	11.7	10.2	11.9	13.0	11.2
SiO_2	.9	2.4	4.3	12.5	1.9
Al_2O_3	27.0	29.0	25.2	20.1	25.7
S				Trace.	None.
P				Trace.	None.
Ni			Present.	Trace.	Present.

2, Cayoguan claim; 3, Narciso claim; 4, Cromita claim, north body; 5, Cromita claim, middle body; 6, Cromita claim, south body.

The deposits of the Cayoguan group contain probably about 22,500 tons of available chromite, but possibly may yield 60,000 tons or more. These estimates include 2,000 tons of float ore in Cayoguan River and a tributary arroyo.

This group of deposits is about 8 miles by trail from an old wharf at Punta Gorda, to which a road will have to be built down the valley of the Cayoguan, a narrow gorge bordered at many places by steep cliffs. Three kinds of road have been suggested—a road for oxcarts, a light tramway for mule cars, and a narrow-gage steam railway. A road for oxcarts appears to be the most practicable in view of the quantity of ore available and the small possible daily output.

The next deposit toward the southeast that was examined is on a claim known as the Potosi, which is on Saltadero Creek about 4 miles above its mouth. This creek is a tributary of Yamaniguey River, which enters Canete Bay about 4 miles below the mouth of the creek.

The ore body is a steeply dipping lens that reaches a depth of more than 100 feet and at one place has a thickness of 25 feet and a length along the strike of 45 feet. The upper edge crops out on the steep mountain side about 325 feet above Saltadero Creek and about 600 feet above sea level. Below this outcrop the ore body has been prospected by two drifts, started 50 and 100 feet below the outcrop, and by a crosscut around the hillside about 80 feet distant from and a little lower than the upper drift. All these openings reach the ore body within short distances but do not intersect it in such a way as to show definitely its dimensions.

The ore is medium to coarse grained. Some of the material in the drifts is spotted, but most of the outcropping and float ore is black and of good appearance. According to analyses that accompany the report of G. W. Maynard, an engineer who prospected the deposit in 1903, the representative ore contains 35 to 41 per cent of chromic oxide, 1.4 to 15 per cent of iron, 1.5 to 5 per cent of silica, 5 to 17.5 per cent of magnesia, and 25 to 29 per cent of alumina. The ore body contains small masses of peridotite, which may reduce materially the quantity of ore available, as well as seams of serpentine and olivine. This deposit contains 10,000 to perhaps 20,000 tons.

The work of getting this ore to the coast involves a difficult problem in transportation. The gorge of Saltadero Creek is too narrow and winding and in places too steep to permit the construction of a road of any kind except at great expense, and even if a road could be built down to the mouth of Yamaniguey River it is doubtful whether steamers of proper draft could enter Canete Bay. The only feasible plan appears to be that of constructing an aerial tramway, about 3 miles long, from the deposit over the mountain and down to a point on the coast about 2 miles southeast of Canete Bay, from which a cart road or light tramway may be built possibly 9 miles southeastward to Taco Bay, where there is fair anchorage for steamers.

A small body of chromite occurs on the Constancia claim, three-quarters of a mile south of Navas Bay, about 100 feet above sea level. The ore body appears to extend about 50 feet along the face of a gently sloping hill and has been opened by a cut 25 feet long and 5½ feet deep. The ore is not of uniform quality. It is mostly "spotted" ore; that is, it is chromite mixed with much serpentine gangue, but about 6 feet of better ore is exposed in the cut. A representative sample of the poorer ore contained 27.6 per cent of chromic oxide, and a sample of the better ore contained 39.4 per cent of chromic oxide, as indicated in the analyses below by R. C. Wells.

Analyses of chromite from Constancia claim, near Navas Bay.

	7	8
Cr_2O_3	27.6	39.4
Fe	11.9	11.5
SiO_2	8.9	4.9
Al_2O_3	25.3	20.5

7, mixed ore; 8, clean ore.

The ore might perhaps be concentrated. No estimate of the quantity of ore in this deposit could be made. Very little float was seen near it and there are no indications of the occurrence of a large deposit. Water for concentration is available near by in Navas River, and a road could easily be built to Navas Bay, which, however, is not deep enough for steamers, so that the ore would have to be lightered 4 miles northwestward to Taco Bay or 10 miles southeastward to Baracoa.

It is credibly reported that a body of at least 10,000 tons of ore similar to the low-grade ore at the Constancia claim lies in the mountains 8 miles south of Navas Bay, but this deposit could not be examined within the time available.

SUMMARY.

The reserves of marketable chromite in Cuba are estimated to range from 92,500 long tons to 170,000 long tons, nearly all of it in Oriente and Camaguey provinces. The largest known deposits of chromite in Cuba—those of the Caledonia, Cayoguan group, and Potosi claims—are near the northeastern coast of Oriente in a region difficult of access. They may yield 72,500 to possibly 130,000 tons of ore, most of which can be brought to present commercial grade by simple concentration. At the time of the examination only one deposit was ready for production and on a small scale, but the rate of production could be greatly increased by the use of an aerial tramway. It would probably require more than a year to put the other deposits in eastern Oriente in shape for production.

The next largest known group of deposits is near Camaguey. They are very easy of access but are of lower grade than those in Oriente Province. They appear to contain 20,000 to 40,000 tons of ore, most of which can be gathered by hand from the surface.

Near Matanzas, Cardenas, and Holguin there are a few small deposits of ore, and since the visit of the writer other similar deposits are reported to have been discovered. The ore near Holguin is of medium grade; that near Matanzas and Cardenas is generally of lower grade. The expense of hauling the ore is reported to have been almost prohibitive during the war, and thus to have retarded production.

Records and estimates indicate that the total production of chrome ore in Cuba to the end of 1918 had been between 7,500 and 8,000 gross tons of the equivalent of 50 per cent chromic oxide.

CHROMIFEROUS IRON ORE.

Extensive deposits of chromiferous iron ore occur near the north coast of Cuba in Oriente and Camaguey provinces. The principal areas in which they are found are the Mayari district, 12 miles south of Nipe Bay, the Moa district, about 50 miles east of Nipe Bay, both in Oriente Province, and the Cubitas district, 15 miles north of the city of Camaguey, in the province of the same name. The deposits occur as lateritic mantles overlying serpentine and are spread over many square miles of plateaus, flat-topped ridges, and gentle mountain slopes.

The ore is hydrous iron oxide, chiefly in the form of ferruginous yellow clay, with a top layer of spongy limonite and small hard pellets of limonite. The thickness of the deposits varies, the pellet or "shot" ore generally not exceeding a few feet, but the ferruginous clay is in places more than 50 feet deep. The percentage of chromium present is generally small, but fairly constant, and serves to distinguish the ore as chromiferous as compared with the bulk of the brown iron ore mined in the southern Appalachian region of the United States. Locally, deposits contain abnormal percentages of chromium, such portions probably representing residual accumulations from broken-down bodies of chromite, such as have been described in preceding pages. Nickel is present also in the ore but to a less extent than chromium. The following analyses are representative of ores from the principal districts:

Analyses of chromiferous iron ores from Cuba.

	1	2	3	4	5
Fe	46.03	46.75	46.23	42.48	45.18
SiO_2	5.50	1.71	2.06	3.01	6.75
Al_2O_3	10.33	11.60	2.16	6.12	12.03
Cr	1.73	1.81	2.07	.39	1.7
TiO_2		.14			
CaO					2.00
Ni					.53
P	.015	.031	.021	.032	.1
S					.063
Mn					.56
H_2O	13.62	13.15	Not det.	Not det.	12.00

1. Mayari iron ore: Iron Age, vol. 80, No. 7, p. 424, Aug. 15, 1907.
2. Moa iron ore: Am. Inst. Min. Eng. Trans., vol. 40, p. 302, 1909.
3. Taco iron ore: Idem.
4. Navas iron ore: Idem.
5. San Felipe iron ore (average of 10 samples): Am. Inst. Min. Eng. Trans., vol. 42, p. 124, 1911.

The Mayari district is the only one in which mining operations are carried on. Here, after careful study, successful large-scale methods were developed for mining, handling, and transporting the raw ore from the plateau down to Nipe Bay, where it is subjected to treatment which not only dries the claylike material but produces incipient fusion, or nodulization. The ore lies on a plateau about 1,700 feet above sea level. It is mined from open pits by drag-line excavators and carried down inclined planes in specially devised dump cars attached to cables to Piedra Gorda, whence locomotives haul it 13 miles to Felton, on Nipe Bay. The roasting and nodulizing are carried on in large rotary kilns, heated by pulverized coal and identical with those used in the manufacture of Portland cement. The raw ore as mined in 1918 carried about 1.5 per cent chromium and between 0.5 and 1 per cent of nickel. In nodulizing the greater part of the water is driven off and the percentages of the metallic constituents are increased proportionately so that the chromium rises to about 2 per cent. Both the chromium and nickel contents are utilized in making "Mayari" steel, in which 1.3 to 1.5 per cent of nickel and 0.3 to 0.5 per cent of chromium are present.[1] The ore is used chiefly in the Sparrows Point, Md., and Steelton, Pa., plants of the Bethlehem Steel Co.

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[1] Communication from Bethlehem Steel Co., Feb. 14, 1918.

As used in the blast furnace the nodulized mineral produces a white pig iron which can be blown in an acid Bessemer converter by the Carney patent. The chromium is retained in the oxidized state by keeping the temperature of the blast low, and the chromic oxide is separated in the slag. The blown metal is carburized in a basic open-hearth furnace.

Estimates of the quantity of ore in these huge deposits indicate from 1,500,000,000 to 2,000,000,000 tons in reserve. As is indicated above, the ore is not used directly as a source of chromium, the treatment tending to eliminate a large part of it in making steel, as it is preferable to add chromium in the form of ferrochrome, when larger quantities are desired.

For the information of the reader who desires to look further into the subject the following list of papers is appended:

Spencer, A. C., Three deposits of iron ore in Cuba: U. S. Geol. Survey Bull. 340, pp. 318-329, 1908.

Weld, C. M., The residual brown iron ores of Cuba: Am. Inst. Min. Eng. Trans., vol. 40, pp. 299-312, 1909.

Cox, J. S., jr., The iron-ore deposits of the Moa district, Oriente Province, Island of Cuba: Am. Inst. Min. Eng. Trans., vol. 42, pp. 73-90, 1911.

Leith, C. K., and Mead, W. J., Origin of the iron ores of central and northeastern Cuba: Idem, pp. 90-102.

Spencer, A. C., Occurrence, origin, and character of the surficial iron ores of Camaguey and Oriente provinces, Cuba: Idem, pp. 103-109.

Hayes, C. W., The Mayari and Moa iron-ore deposits in Cuba: Idem, pp. 109-115.

Cumings, W. L., and Miller, B. L., Characteristics and origin of the brown iron ores of Camaguey and Moa, Cuba: Idem, pp. 116-137.

Woodbridge, D. E., Exploration of Cuban iron-ore deposits: Idem, pp. 138-152.

Little, J. E., The Mayari iron mines, Oriente Province, Island of Cuba, as developed by the Spanish-American Iron Co.: Idem, pp. 152-169.

Kemp, J. F., The Mayari iron-ore deposits, Cuba: Am. Inst. Min. Eng. Trans., vol. 51, pp. 3-30, 1915.

GOLD AND SILVER.

(GENERAL REPORT.)

By J. P. Dunlop.

PRODUCTION.

DOMESTIC PRODUCTION.

Approximate distribution, by producing States and Territories, of the production of gold and silver in the United States for 1918.[a]

State or Territory.	Gold.		Silver.	
	Quantity (fine ounces).	Value.	Quantity. (fine ounces).	Commercial value.
Alabama	34	$700	2	$2
Alaska	455,920	9,424,700	802,743	787,057
Arizona	270,078	5,583,000	6,831,465	6,697,978
California	811,945	16,784,400	1,432,812	1,404,815
Colorado	615,558	12,724,700	6,900,266	6,765,435
Georgia	218	4,500	45	44
Idaho	33,930	701,400	9,396,009	9,212,411
Illinois	....	....	8,218	8,057
Maine	34	700	6,338	6,214
Maryland	....	....	164	161
Michigan	....	....	516,294	506,206
Missouri	3	60	42,214	41,389
Montana	158,704	3,280,700	16,378,263	16,058,232
Nevada	324,134	6,700,440	9,931,969	9,737,898
New Hampshire	....	....	691	678
New Mexico	33,237	687,080	773,662	758,545
North Carolina	213	4,400	100	98
Oregon	61,228	1,265,700	129,150	126,626
Philippine Islands	62,404	1,290,000	13,000	12,746
Porto Rico	5	100	....	....
South Dakota	324,083	6,699,400	161,232	158,082
Tennessee	271	5,600	105,829	103,761
Texas	1	20	579,158	567,841
Utah	152,526	3,153,000	13,492,555	13,228,911
Vermont	48	1,000	4,891	4,795
Virginia	19	400	1,814	1,779
Washington	16,148	333,800	300,000	294,138
Wyoming	43	900	1,255	1,230
	3,320,784	68,646,700	67,810,139	66,485,129

[a] Gold value $20.67+ per fine ounce. Average commercial (dealers') buying price of silver 0.999 fine in 1918, $0.98046 per fine ounce.

The figures in this table result from cooperation of the United States Bureau of the Mint and the United States Geological Survey and are agreed upon after conference and adjustment between the two bureaus. They are, therefore, final for both.

The totals are based on bullion deposits in the United States mints and assay offices and on returns to the Bureau of the Mint from the smelting and refining companies. The distribution is adjusted by information collected by the United States Geological Survey directly from the producing mines and tabulated for the mines reports later discussed. The data giving the total production, and in part the distribution, are obtained from records of (1) the unrefined domestic gold and silver deposited in United States mints and assay offices, (2) the domestic gold and silver in fine bars reported by private refineries, and (3) the unrefined domestic gold and silver contained in ores and matte exported for reduction. The last item is of small relative importance.

Increase or decrease in production of gold and silver in the United States in 1918.

State or Territory.	Gold.		Silver.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.
Alabama	− 72	− $1,500	+ 2	+ $2
Alaska	−253,809	−5,246,700	− 404,421	− 207,043
Arizona	+ 19,465	+ 402,400	− 130,792	+ 964,578
California	−200,516	−4,145,000	− 674,295	− 330,385
Colorado	−157,208	−3,249,800	− 391,229	+ 760,935
Georgia	− 96	− 2,000	+ 45	+ 44
Idaho	− 2,581	− 53,400	−2,006,533	− 177,589
Illinois			+ 1,102	+ 2,157
Maine	+ 34	+ 700	+ 6,338	+ 6,214
Maryland			− 374	− 239
Michigan			− 167,931	− 57,194
Missouri	− 12	− 240	− 21,130	− 10,811
Montana	− 18,986	− 392,500	+1,823,229	+4,072,132
Nevada	− 11,227	− 232,060	−1,285,685	+ 500,198
New Hampshire			+ 691	+ 678
New Mexico	− 19,268	− 398,320	− 762,145	− 506,155
North Carolina	− 311	− 6,400	− 490	− 402
Oregon	− 20,396	− 421,600	− 43,002	− 15,174
Philippine Islands	− 7,549	− 156,100	+ 285	+ 2,246
Porto Rico				
South Carolina	− 82	− 1,700		
South Dakota	− 32,579	− 673,500	− 29,150	+ 1,282
Tennessee	+ 4	+ 100	− 1,146	+ 15,661
Texas	− 4	− 80	− 8,787	+ 83,641
Utah	− 17,857	− 369,100	+ 131,650	+2,226,211
Vermont	+ 43	+ 900	+ 4,488	+ 4,495
Virginia	− 44	− 900	− 2,686	− 1,921
Washington	− 7,469	− 154,400	+ 33,888	+ 75,088
Wyoming	− 136	− 2,800	− 2,145	− 1,570
Increase or decrease	−730,656	−15,104,000	−3,930,223	+7,407,029

In addition to the gold and silver produced by domestic smelters and refiners from domestic sources in 1918, amounting to 3,320,784 fine ounces of gold and 67,810,139 fine ounces of silver, these plants produced 566,886 fine ounces of gold and 55,979,420 fine ounces of silver from foreign ores and bullion, a decrease of 202,285 ounces of gold and an increase of 5,872,609 ounces of silver compared with the corresponding figures for 1917. The foreign ores producing this bullion came mainly from Mexico and Canada.

The value of the new gold used in the arts and industries in the United States in 1918 was $32,892,395, as compared with $34,803,445 in 1917, and the quantity of silver used for such purposes in 1918 was 26,722,333 fine ounces, compared with 15,998,807 ounces in 1917. Part of the large increase of about 10,724,000 ounces of silver so used was due to the expansion of the photograph-film and moving-picture industries. The consumption of silver in the arts and industries was equal to 39 per cent of the domestic production and that of gold to 48 per cent of the domestic production. In addition to the gold and silver derived from foreign and domestic ores and bullion 819,067 fine ounces of gold and 8,526,122 fine ounces of silver were recovered from old jewelry, dental waste, silverware, and other old material.

PRICES OF SILVER.

The average official monthly prices of fine bar silver in New York in 1918 were as follows:

Price of silver per fine ounce in 1918, by months.[1]

Month	Price	Month	Price
January	$0.93201	August	$1.00417
February	.88983	September	1.01250
March	.92096	October	1.01250
April	.97822	November	1.01250
May	.99505	December	1.01275
June	.99750		
July	.99750	Yearly average	.98046

The average annual price of silver per fine ounce from 1865 to 1918, inclusive, has been as follows:

Price of silver per fine ounce, 1865–1918.[2]

Year	Price	Year	Price	Year	Price
1865	$1.337	1883	$1.11	1901	$0.60
1866	1.339	1884	1.11	1902	.53
1867	1.33	1885	1.07	1903	.54
1868	1.326	1886	.99	1904	.58
1869	1.325	1887	.98	1905	.61
1870	1.328	1888	.94	1906	.68
1871	1.325	1889	.94	1907	.66
1872	1.322	1890	1.05	1908	.53
1873	1.297	1891	.99	1909	.52
1874	1.278	1892	.87	1910	.54
1875	1.24	1893	.78	1911	.53
1876	1.16	1894	.63	1912	.615
1877	1.20	1895	.65	1913	.604
1878	1.15	1896	.68	1914	.553
1879	1.12	1897	.60	1915	.507
1880	1.15	1898	.59	1916	.658
1881	1.13	1899	.60	1917	.824
1882	1.14	1900	.62	1918	.980

PRODUCTION OF GOLD AND SILVER SINCE 1792.

According to tables published by the Director of the Mint the total production of gold and silver in the United States is as follows:

Gold and silver produced in the United States, 1792–1918.

[The estimate for 1792–1872 is by R. W. Raymond, commissioner, and for the period since 1872 by the Director of the Mint.]

Period.	Gold.		Silver.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.
1792–1847	1,187,170	$24,537,000	309,500	$404,500
1848–1872	58,279,778	1,204,750,000	118,568,200	157,749,900
1873–1918	133,131,361	2,752,067,600	2,328,469,878	1,803,344,429
	192,598,309	3,981,354,600	2,447,347,578	1,961,498,829

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[1] This represents average official quotations for sale by the Mint and is above dealers' prices for silver 0.999 fine.

[2] Based on London price of bar silver 1.000 fine and taken at average price and par of exchange, 1865–1915; New York dealers' buying price for 1916–1918.

These figures show a total production of gold for the United States, from the earliest mining to the end of 1918, of 192,598,309 ounces, valued at nearly $3,981,355,000, and an output of silver of nearly 2,447,347,600 ounces, valued at more than $1,961,498,000. Although the output of gold was less than one-twelfth the output of silver in quantity, its value was more than twice that of the silver.

The average commercial value per fine ounce of silver for the 126 years contributing to the total domestic production was a little more than $0.80. Fluctuations in value of silver per fine ounce are shown in the curve in figure 12. It is of interest to note that the average value for the total output of silver was reached in 1893. For the years shown (1871 to 1918, inclusive), the average annual value was above $0.80 before 1893, and has been below that figure every year since until 1917, when the average value was $0.8235, or 2.35 cents more than the average value 1871–1918, and in 1918 when the average value was $0.98046, or about 18 cents more.

Gold and silver produced in the United States, 1880-1918.

Year.	Gold.		Silver.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.
1880	1,741,500	$36,000,000	30,318,700	$34,717,000
1881	1,678,612	34,700,000	33,257,800	37,657,500
1882	1,572,187	32,500,000	36,196,900	41,105,900
1883	1,451,250	30,000,000	35,732,800	39,618,400
1884	1,489,950	30,800,000	37,743,800	41,921,300
1885	1,538,373	31,801,000	39,909,400	42,503,500
1886	1,686,788	34,869,000	39,694,000	39,482,400
1887	1,603,049	33,136,000	41,721,600	40,887,200
1888	1,604,478	33,167,500	45,792,700	43,045,100
1889	1,594,775	32,967,000	50,094,500	46,838,400
1890	1,588,877	32,845,000	54,516,300	57,242,100
1891	1,604,840	33,175,000	58,330,000	57,630,000
1892	1,597,098	33,015,000	63,500,000	55,662,500
1893	1,739,323	35,955,000	60,000,000	46,800,000
1894	1,910,813	39,500,000	49,500,000	31,422,100
1895	2,254,760	46,610,000	55,727,000	36,445,500
1896	2,568,132	53,088,000	58,834,800	39,654,600
1897	2,774,935	57,363,000	53,860,000	32,316,000
1898	3,118,398	64,463,000	54,438,000	32,118,400
1899	3,437,210	71,053,400	54,764,500	32,858,700
1900	3,829,897	79,171,000	57,647,000	35,741,100
1901	3,805,500	78,666,700	55,214,000	33,128,400
1902	3,870,000	80,000,000	55,500,000	29,415,000
1903	3,560,000	73,591,700	54,300,000	29,322,000
1904	3,892,480	80,464,700	57,682,800	33,456,000
1905	4,265,742	88,180,700	56,101,600	34,222,000
1906	4,565,333	94,373,800	56,517,900	38,256,400
1907	4,374,827	90,435,700	56,514,700	37,299,700
1908	4,574,340	94,560,000	52,440,800	28,050,600
1909	4,821,701	99,673,400	54,721,500	28,455,200
1910	4,657,018	96,269,100	57,137,900	30,854,500
1911	4,687,053	96,890,000	60,399,400	32,615,700
1912	4,520,717	93,451,500	63,766,800	39,197,500
1913	4,299,783	88,884,400	66,801,500	40,348,100
1914	4,572,976	94,531,800	72,455,100	40,067,700
1915	4,887,602	101,035,700	74,961,075	37,397,300
1916	4,479,056	92,590,300	74,414,802	48,953,000
1917	4,051,440	83,750,700	71,740,362	59,078,100
1918	3,320,784	68,646,700	67,810,139	66,485,129
	119,591,597	2,472,175,800	2,120,060,178	1,552,270,029

IMPORTS AND EXPORTS.

Value of gold and silver imported and exported, in 1918.

	Imports.	Exports.	Excess of—	
			Imports.	Exports.
GOLD.				
Contained in domestic ore and base bullion		$206,674		$206,674
Contained in foreign ore and base bullion	$16,251,930		$16,251,930	
Domestic bullion refined		8,052,578		8,052,578
Foreign bullion refined	38,911,037		38,911,037	
United States coin	6,743,464	32,431,889		25,688,425
Foreign coin	136,317	378,677		242,360
	62,042,748	41,069,818	55,162,967	34,190,037
Excess			20,972,930	
SILVER.				
Contained in domestic ore and base bullion		18,248		18,248
Contained in foreign ore and base bullion	44,877,920		44,877,920	
Domestic bullion refined		236,411,329		236,411,329
Foreign bullion refined	20,619,195	6,016,337	14,602,858	
United States coin	1,267,837	3,542,926		2,275,089
Foreign coin	4,610,747	6,857,624		2,246,877
	71,375,699	252,846,464	59,480,778	240,951,548
Excess				181,470,765

DOMESTIC SUPPLY.

The remarkable gain in domestic supply of gold indicated by the great excess of $530,200,000 in imports over exports for 1916, or $76,000,000 more than the world's total output of new gold for that year, was due to the fact that this country has been a creditor nation since the last great movements of its gold abroad. This movement was much less conspicuous in 1917, though the excess of imports of gold in ore, bullion, and coin amounted to more than $180,000,000, owing largely to the imports of foreign refined bullion. In 1918 the excess of gold imports was only about $21,000,000, and this was due mainly to the gold contained in foreign ore and base bullion. The United States is now the largest creditor nation in the world, but very little gold is available to settle trade balances, and the imports of gold are not likely to be in excess of exports in 1919. For the first six months of 1919 the excess of gold exports has been more than $46,000,000. The continuation of large exports of silver to the Far East, and especially to the Entente nations in Europe, was due largely to the demand for exchange and for the coinage of silver money to pay troops in the field. The value of refined domestic silver bullion exported was about $236,400,000, or more than five times the silver contained in imported foreign ore and base bullion and about $170,000,000 more than the value of the domestic production. The total quantity of silver dollars remelted up to July 1, 1918, under the Pittman Act, passed by Congress in April, 1918, was 260,000,000 ounces, and most of the bullion was exported to India and China.

The domestic supply of new gold comes chiefly from dry or siliceous gold ores, treated mainly in gold mills by amalgamation or cyanidation, or both, and partly by smelting, and from placer gravels worked largely by dredging. As shown on page 761 these ores and placer gravels supplied 87.3 per cent of the yield of gold in 1918. Examples of gold milling ores are those of the Homestake mines of South Dakota, the Goldfield mines in Nevada, the Grass Valley and Mother

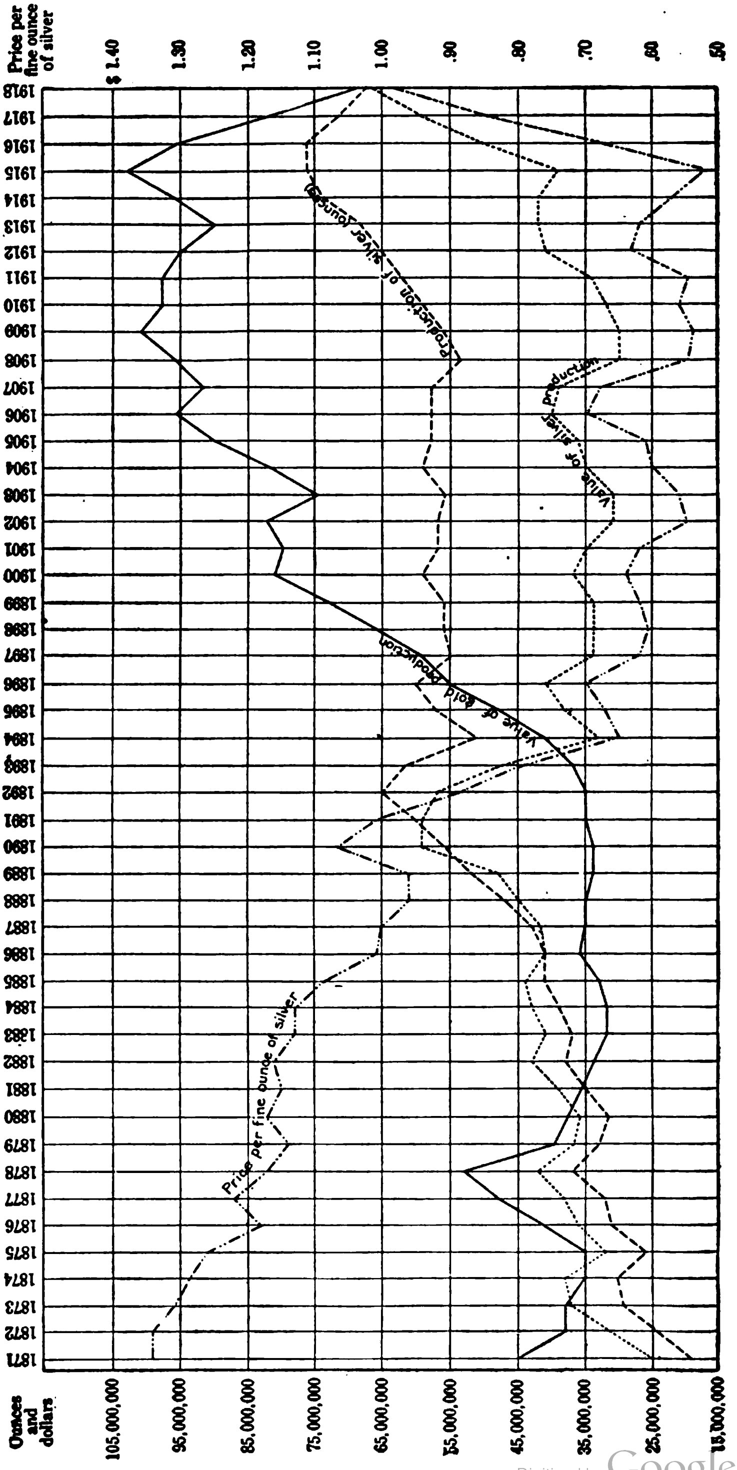


FIGURE 12.—Curve showing production and value of gold and silver and price per fine ounce of silver in the United States, 1871–1918.

Lode mines of California, the Alaska mines of the Juneau district, and the Cripple Creek and upper San Miguel County mines in Colorado. The great gold-dredging fields of California, especially of the Marysville district, are examples of the placer gravels worked on a large scale. A considerable output of gold is also now recovered from the refining of copper bullion from copper ores, especially of the West Mountain or Bingham district, Utah, and the Summit Valley or Butte district, Mont. In 1918 the copper ores of the United States produced more than 9.6 per cent of the total gold, against 8.7 per cent in 1917. The natural tendency is for the proportionate output from gold ores to decrease with declining yield from some of the principal gold camps and for that from copper ores to increase, with a general net falling off of total yield of gold owing to the preponderant output from gold and gold-silver ores.

The principal domestic supply of new silver came from dry or siliceous silver and silver-gold ores, copper ores, lead ores, and lead-zinc ores in the proportion of 31.7, 30, 26.9, and 10.7 per cent, respectively, in 1918, against 30.4, 28.8, 27, and 12.2 per cent, respectively, in 1917. The dry or siliceous silver-gold ores have come chiefly from four large mines of the Tonopah district, Nev., and declining output from this camp more than offsets gains from such ores elsewhere. The bulk of the silver ores of this class are milled and cyanided at or near the mines, although a small quantity of richer ores is shipped to copper and lead smelters. The largest single producer of silver in 1918 from domestic mines was the Anaconda Copper Mining Co., of Montana, producing from copper ores; the second largest was the Chief Consolidated Mining Co., of Utah., producing from lead ores; and the third largest was the Butte & Superior Mining Co., of Montana, producing from lead-zinc ores. Of the 25 mines or groups of mines producing silver on the largest scale, 5 were silver-gold and silver mines, 7 were copper mines, 11 were lead mines, and 2 were zinc-lead mines. With large recent increase in output of argentiferous copper, lead, and zinc-lead ores, the domestic silver output has been fairly well maintained against decline from silver-gold and (the rare) silver ores. The silver obtained as a by-product from copper, lead, and zinc ores is derived from refining the copper and lead bullion produced in smelting those and other ores.

WORLD'S PRODUCTION OF GOLD.

Value of gold produced in the world, 1860–1918.

[The annual production from 1860 to 1872 is obtained from statistics for 5-year periods compiled by Dr. Adolph Soetbeer. Since 1872 the estimates are those of the Bureau of the Mint. See Pl. VII.]

Calendar year.	Value.	Calendar year.	Value.	Calendar year.	Value.	Calendar year.	Value.
1860	$134,083,000	1876	$103,700,000	1892	$146,651,500	1908	$442,476,900
1861	122,989,000	1877	113,947,200	1893	157,494,800	1909	454,059,100
1862	122,989,000	1878	119,092,800	1894	181,175,600	1910	455,239,100
1863	122,989,000	1879	108,778,800	1895	198,763,600	1911	461,939,700
1864	122,989,000	1880	106,436,800	1896	202,251,600	1912	466,136,100
1865	122,989,000	1881	103,023,100	1897	236,083,700	1913	460,497,204
1866	129,614,000	1882	101,996,600	1898	286,879,700	1914	439,029,702
1867	129,614,000	1883	95,392,000	1899	306,724,100	1915	468,724,918
1868	129,614,000	1884	101,729,600	1900	254,576,300	1916	454,176,500
1869	129,614,000	1885	108,435,600	1901	260,992,900	1917	419,422,100
1870	129,614,000	1886	106,163,900	1902	296,737,600	1918	380,924,500
1871	115,577,000	1887	105,774,900	1903	327,702,700		
1872	115,577,000	1888	110,196,900	1904	347,377,200		12,972,153,524
1873	96,200,000	1889	123,489,200	1905	380,288,700		
1874	90,750,000	1890	118,848,700	1906	402,503,000		
1875	97,500,000	1891	130,650,000	1907	412,966,600		

In 1918 the estimated total production of gold in the world decreased nearly $38,500,000, following a decrease of about $35,000,000 in 1917. The production of the United States decreased $15,000,000; Canada, $585,000; Africa, $17,200,000; Australasia, $5,100,000; and Russia, $6,000,000.

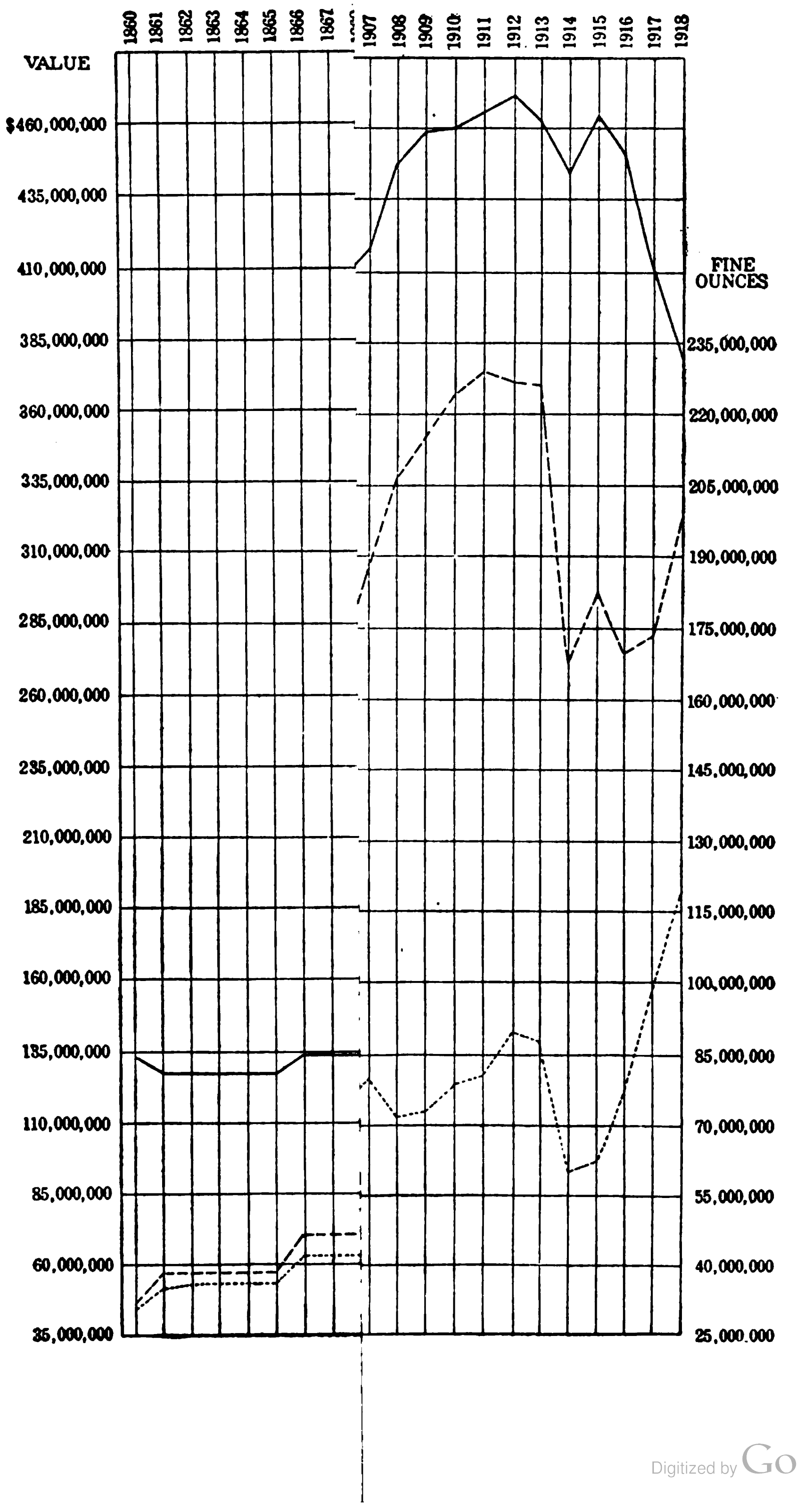
The production of Mexico increased about $7,800,000 in 1918 and there was also a small increase in Central America.

A valuable paper on "Gold and silver deposits in North and South America" was read by Waldemar Lindgren at the Second Pan American Scientific Congress and has been republished in the Transactions of the American Institute of Mining Engineers, volume 55, pages 883–909, 1917.

In the following table is shown the output of gold, by countries, as given by the Bureau of the Mint:

World's production of gold, 1907–1918.

Country.	1907	1908	1909	1910	1911	1912
North America:						
United States	$90,435,700	$94,560,000	$99,673,400	$96,269,100	$96,890,000	$93,451,500
Canada	8,382,800	9,482,100	9,382,200	10,205,800	9,762,100	12,648,800
Mexico	18,681,100	22,371,200	23,842,900	24,910,600	24,880,100	24,500,000
Cuba	....	....	....	....	20,000	....
Africa	151,984,100	166,520,500	170,988,600	175,189,900	191,538,400	211,850,600
Australasia	75,677,700	73,327,300	71,007,900	65,470,600	60,184,200	54,509,400
Europe:						
Russia and Finland	26,684,300	28,052,200	32,381,300	35,579,600	32,151,600	22,199,000
Austria-Hungary	2,484,900	2,469,300	1,942,000	2,172,600	2,185,100	2,043,200
Germany	66,600	64,800	69,200	62,900	78,100	78,100
Norway	....	....	....	1,400	....	....
Sweden	18,700	14,500	10,100	2,000	2,000	20,300
Italy	39,600	46,500	24,200	29,600	44,800	11,000
Spain and Portugal	....	....	2,900	2,800	2,400	2,300
Turkey	4,500	2,200	500	500	500	500
France	835,400	1,147,400	1,400,600	1,707,100	1,812,100	1,812,100
Great Britain	29,200	16,000	21,500	39,600	39,600	27,800
Serbia	59,800	59,800	150,300	....	251,100	251,100
South America:						
Argentina	103,000	161,300	189,900	173,100	289,000	107,300
Bolivia Chile	1,267,400	346,800	492,400	463,600	362,500	175,000
Colombia	3,255,600	3,427,300	3,179,900	3,370,000	3,167,800	2,971,700
Ecuador	267,100	350,300	274,400	249,200	276,800	406,500
Brazil	2,020,700	2,196,600	2,252,900	1,954,700	3,834,500	3,570,600
Venezuela	22,400	24,500	280,600	340,500	364,800	623,500
Guiana:						
British	1,304,400	1,408,100	1,192,700	1,192,700	892,000	879,800
Dutch	640,000	663,000	621,000	792,600	523,400	407,300
French	2,360,800	2,135,500	2,143,800	2,229,100	2,229,100	3,050,600
Peru	514,500	514,500	514,500	455,900	492,300	492,200
Uruguay	51,900	91,600	91,600	91,600	70,600	111,000
Central America	2,107,800	3,018,800	2,630,100	4,657,400	3,360,400	3,030,400
Asia:						
Japan	2,773,000	3,321,600	3,616,900	3,903,600	4,118,600	4,467,000
China	4,500,000	8,647,300	9,352,100	3,658,100	3,314,600	3,658,900
Indo-China	31,800	65,600	65,600	55,000	74,700	74,700
Chosen (Korea)	2,170,800	3,047,500	1,993,600	4,399,100	2,889,400	2,852,600
Siam	166,200	327,600	327,600	56,500	56,500	56,500
India, British	10,383,600	10,598,500	10,358,600	10,718,400	11,054,100	11,055,700
East Indies, British	1,561,300	1,400,900	1,436,900	1,446,800	1,339,400	1,352,000
East Indies, Dutch	2,079,900	2,596,300	2,146,400	3,387,100	3,387,100	3,387,100
	412,966,600	442,476,900	454,059,100	455,239,100	461,939,700	466,136,100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100,000,000
85,000,000
70,000,000
55,000,000
40,000,000
25,000,000

World's production of gold, 1907–1918—Continued.

Country.	1913	1914	1915	1916	1917	1918
North America:						
United States	$88,884,400	$94,531,800	$101,035,700	$92,590,300	$83,750,700	$68,646,700
Canada	16,598,900	15,983,004	18,977,901	19,235,000	15,273,000	14,687,900
Mexico	19,308,800	4,788,175	6,559,275	7,690,700	9,000,000	16,824,700
Africa	207,326,500	201,996,796	217,851,898	222,948,900	214,304,300	197,073,600
Australasia	53,113,200	47,569,023	48,898,177	40,475,800	34,398,100	29,268,600
Europe:						
Russia, Finland and Siberia	26,508,700	28,586,392	26,322,746	22,500,000	18,000,000	12,000,000
Austria-Hungary	2,179,300	200,744	1,392,465	1,000,000	150,000	180,000
Germany	135,600	....	....	....	....	....
Sweden	17,600	54,304	25,323	12,200	10,000	10,000
Italy	17,200	32,145	2,295	2,000	700	22,800
Spain and Portugal	2,300	2,336	661	....	....	....
Turkey	500	475	475	....	....	....
France	2,127,400	1,400,000	1,400,000	1,000,000	700,000	500,000
Great Britain	17,900	20,238	19,266	5,706	5,000	....
Serbia	328,000	116,000	....	....	....	....
South America:						
Argentina	2,600	....	....	15,300	4,600	4,000
Bolivia and Chile	336,884	202,770	814,418	301,000	770,700	770,000
Colombia	2,971,700	4,678,587	5,453,148	6,173,900	5,000,000	4,866,500
Ecuador	406,500	346,853	545,674	566,000	887,800	800,000
Brazil	2,254,700	2,139,803	2,424,515	2,890,000	2,958,000	2,800,000
Venezuela	419,040	564,220	1,395,349	1,269,900	636,900	478,200
Guiana:						
British	1,353,500	1,126,500	923,892	660,700	519,000	400,000
Dutch	470,400	503,400	449,054	438,200	445,000	322,200
French	3,050,600	1,959,793	1,959,793	1,600,000	1,438,500	1,100,000
Peru	912,280	1,022,125	1,109,891	1,267,400	1,254,100	1,250,000
Uruguay	29,900	15,276	11,836	12,000	10,000	10,000
Central America	2,721,700	2,393,190	2,970,271	3,517,600	3,122,000	3,400,000
Asia:						
Japan	3,614,400	4,679,358	5,386,066	5,185,600	4,679,700	5,105,900
China	3,658,900	3,658,900	2,804,692	3,100,700	3,600,100	3,600,000
Indo-China	74,700	66,419	43,659	65,600	50,000	50,000
Chosen (Korea)	3,582,500	3,309,870	3,739,477	4,122,400	3,363,800	3,300,000
Siam	56,500	....	....	....	....	....
India, British	12,178,000	11,378,400	11,522,457	11,206,500	10,812,800	10,028,000
East Indies, British	1,352,000	4,480,853	3,100,000	3,000,000	2,853,700	2,571,400
East Indies, Dutch	3,387,100					
Federated Malay States	282,400	269,147	351,527	327,900	342,400	345,300
Formosa	814,600	952,806	1,143,017	1,001,200	1,081,200	513,700
	460,497,204	439,029,702	468,724,918	454,176,500	419,422,100	380,924,500

For some foreign countries, owing to the difficulty of obtaining accurate statistics since the beginning of the European war, estimates have been made for 1914, 1915, 1916, 1917, and 1918; for a few other countries, because of lack of basis for estimates, the figures for preceding years have been repeated.

The figures given for the years 1904 to 1912, inclusive, are taken from the reports of the Director of the Mint. The statistics for 1913 to 1918, inclusive, were mainly adjusted in conference between the Mint and the Geological Survey.

The notable increase of total world's output of gold culminated in a new record of $468,724,918 in 1915.

The estimated world's production of gold in 1916 was $454,176,500, or about $14,500,000 less than in 1915; that of 1917 was $49,000,000 less than in 1915; and that of 1918, $87,800,000 less than in 1915.

The present tendency, in the absence of discovery and development of new gold fields on a large scale, is toward a declining world's output of new gold, and this tendency is accentuated by the high cost of labor and supplies, which makes the operation of many gold mines unprofitable. There will probably be another substantial decrease in the world's output in 1919, although the production of Canada, Mexico, and some South American countries may show an increase.

WORLD'S PRODUCTION OF SILVER.

The figures for the world's production of silver in 1918 show that the United States and Canada produced about 89,100,000 ounces, or about 45 per cent, against 57 per cent in 1917, and that Mexico, Central America, and South America yielded nearly 81,000,000 ounces, or 41 per cent, so that approximately only 27,300,000 ounces of silver came from all other countries, mainly from Australasia, Japan, and Spain.

There was an increase of 27,500,000 ounces in the quantity of silver produced in Mexico in 1918, but the production from mines in the United States decreased about 3,930.000 ounces and that from Canada 937,000 ounces.

The total increase in the world's production of silver in 1918 was about 23,200,000 ounces, due entirely to the large increase in Mexico, for the total from all other countries decreased more than 4,000,000 ounces, notwithstanding the much higher average selling price of silver in 1918.

World's production of silver, 1907–1918, in fine ounces.

[Figures supplied by U. S. Bureau of the Mint.]

Country.	1907	1908	1909	1910	1911	1912
North America:						
United States	56,514,700	52,440,800	54,721,500	57,137,900	60,399,400	63,766,800
Canada	12,779,800	22,106,233	27,529,473	32,869,264	32,740,748	31,625,451
Mexico	61,147,203	73,664,027	73,942,432	71,372,194	79,032,440	74,640,300
Central America	1,892,896	1,460,809	2,294,272	2,026,885	1,211,747	2,845,954
South America:						
Bolivia and Chile	5,222,358	5,806,117	5,548,154	6,490,163	4,555,043	4,049,856
Argentina	25,178	127,108	265,106	263,255	203,111	81,996
Brazil					47,222	40,610
Colombia	1,048,719	1,375,039	431,204	866,093	817,431	587,683
Ecuador	2,456	22,642	22,642	22,642	22,642	22,642
Peru	9,566,118	9,566,118	9,566,118	6,626,930	8,351,563	8,351,563
Guiana and Uruguay						724,235
Venezuela		104,626	204,958	208,043	436,903	122,303
Europe:						
Austria-Hungary	1,744,233	1,770,457	999,184	1,540,808	1,538,772	1,840,297
Germany	5,088,086	4,971,544	5,332,901	5,597,026	4,984,677	4,964,677
France	794,973	592,042	629,848	713,028	429,831	429,831
Great Britain	137,216	135,255	141,943	136,370	136,370	113,769
Greece	829,025	829,025	829,025	881,539	803,750	803,750
Italy	737,843	674,848	786,620	468,566	998,576	447,761
Norway	201,516	226,175	213,122	229,989	292,075	247,968
Spain and Portugal	4,097,035	4,175,674	4,767,091	4,546,430	4,270,324	5,358,448
Russia	132,122	132,122	132,122	140,632	477,140	200,094
Serbia			11,226		24,132	24,132
Sweden	29,761	35,728	29,373	19,823	19,823	32,202
Turkey	67,351	7,971	1,717,896	1,717,896	1,717,896	1,509,133
Australasia	17,949,099	17,175,099	16,359,284	21,545,828	16,578,421	14,737,944
Asia:						
British India				44,772	104,323	93,649
Chosen (Korea)				164,844	9,446	12,224
Dutch East Indies	335,454	571,953	465,980	465,980	465,980	465,980
Japan	3,073,411	3,887,397	4,130,972	4,581,613	4,459,087	4,932,853
Africa	790,431	1,272,595	1,076,577	1,037,160	1,064,050	
French East Africa Madagascar						73,286
Rhodesia						158,572
Transvaal, Cape Colony, Natal						984,672
	184,206,984	203,131,404	212,149,023	221,715,673	226,192,923	224,310,654

World's production of silver, 1907–1918, in fine ounces—Continued.

Country.	1913	1914	1915	1916	1917	1918
North America:						
United States	66,801,500	72,455,100	74,961,075	74,414,800	71,740,400	67,810,100
Canada	31,524,708	28,406,711	26,625,960	25,459,700	22,221,300	21,284,600
Mexico	70,703,828	27,546,752	39,570,151	22,838,400	35,000,000	62,517,000
Central America	2,135,641	2,754,868	2,920,496	2,602,500	2,369,500	2,900,000
South America:						
Bolivia and Chile	3,932,594	789,685	3,870,065	4,402,100	4,151,600	4,335,000
Argentina	35,271	....	....	21,300	29,000	25,000
Brazil	28,364	76,685	21,523	22,000	25,000	25,000
Colombia	587,683	351,271	351,271	309,400	325,000	325,000
Ecuador	22,642	16,726	24,655	30,000	45,000	40,000
Peru	9,971,067	9,214,190	9,419,950	10,787,000	10,864,400	10,800,000
Guiana and Uruguay	51,111	....	....	8,500	8,000	8,000
Venezuela	....	....	....	....	3,300	3,000
Europe:						
Austria-Hungary	2,104,107	1,572,746	1,772,699	1,500,000	1,500,000	1,750,000
Germany	4,984,677	....	....	....	....	....
France	520,766	....	....	....	....	....
Great Britain	128,543	135,458	96,450	86,500	75,000	50,000
Greece	803,750	591,464	591,464	350,000	350,000	350,000
Italy	423,888	510,365	493,856	486,500	486,500	500,000
Norway	247,988	440,917	413,867	439,100	294,900	270,200
Spain and Portugal	4,437,637	4,434,417	4,567,454	4,517,800	2,850,000	3,100,000
Russia	....	....	638,403	550,000	500,000	400,000
Serbia	28,758	12,014	....	10,000	20,000	20,000
Sweden	58,969	33,511	24,230	37,900	35,000	31,500
Turkey	1,509,133	1,509,133	1,509,133	500,000	400,000	400,000
Australasia	18,128,577	11,000,000	9,250,000	10,700,000	10,000,000	10,000,000
Asia:						
British India	....	236,440	284,875	280,000	275,000	270,000
China	....	....	18,230	30,000	63,900	70,000
Chosen (Korea)	15,048	16,864	21,897	25,000	26,500	26,000
Dutch East Indies	465,980	400,000	400,000	400,000	400,000	400,000
Indo-China	....	1,767	1,056	1,000	1,000	1,000
Formosa	51,763	51,080	47,653	47,700	39,600	26,900
Japan	4,649,910	4,836,228	5,120,293	5,805,700	7,111,700	6,600,400
Burma	....	....	....	977,100	1,793,700	1,970,500
Africa:						
Belgian Kongo	1,454	4,770	4,770	11,000	10,300	10,500
Egypt	....	1,223	1,657	1,200	900	800
French East Africa Madagascar	....	....	....	20,000	20,000	20,000
Rhodesia	121,537	150,794	185,233	200,700	212,000	175,700
Transvaal, Cape Colony, Natal	933,191	901,763	996,379	968,900	938,100	877,500
Portuguese East Africa	....	....	....	1,200	1,200	1,200
	225,410,085	168,452,942	184,204,745	168,843,000	174,187,800	197,394,900

Production of silver in the world, 1860–1918.

[The annual production from 1860 to 1872 is obtained from statistics for 5-year periods compiled by Dr. Adolph Soetbeer. For the period since 1872 the estimates are those of the Bureau of the Mint. See Pl. VII.]

Year.	Quantity (fine ounces).	Commercial value.	Year.	Quantity (fine ounces).	Commercial value.
1860	29,095,428	$39,337,000	1891	137,170,000	$135,500,200
1861	35,401,972	46,191,000	1892	153,151,762	133,404,400
1862	35,401,972	47,651,000	1893	165,472,621	129,119,900
1863	35,401,972	47,616,000	1894	164,610,394	104,493,000
1864	35,401,972	47,616,000	1895	167,500,960	109,545.600
1865	35,401,972	47,368,000	1896	157,061,370	105,859,300
1866	43,051,583	57,646,000	1897	160,421 082	96,252.700
1867	43,051,583	57,173,000	1898	169,055,253	99,742,600
1868	43,051,583	57,086,000	1899	168,337,452	101,002,600
1869	43,051,583	57,043,000	1900	173,591,364	107,626,400
1870	43,051,583	57,173,000	1901	173,011,283	103,806,700
1871	63,317,014	83,958,000	1902	162,763,483	86,264,700
1872	63,317,014	83,705,000	1903	167,689,322	90,552,200
1873	63,267,187	82,120,800	1904	164,195,266	95,233,300
1874	55,300,781	70,674,400	1905	172,317,688	105,113,700
1875	62,261,719	77,578,100	1906	165,054,497	111,721,100
1876	67,753,125	78,322,600	1907	184,206,984	121,577,100
1877	62,679,916	75,278,600	1908	203,131,404	108,655,100
1878	73,385,451	84,540,000	1909	212,149,023	110,364,400
1879	74,383,495	83,532,700	1910	221,715,673	119,727,000
1880	74,795,273	85,640.600	1911	226,192,923	122,143,800
1881	79,020,872	89,925,700	1912	224,310,654	137,883,800
1882	86,472,091	98,232,300	1913	225,410,085	136,153,700
1883	89,175,023	98,984,300	1914	168,452,942	93,174,700
1884	81,567,801	90,785,000	1915	184,204,745	95,587,500
1885	91,609,959	97,518,800	1916	168,843,000	115,905,600
1886	93,297,290	92,793,500	1917	174,187,800	155,941,600
1887	96,123,586	94,031,000	1918	197,394,900	194,327,400
1888	108,827,606	102,185,900			
1889	120,213,611	112,414,100		7,065,831,009	5,602,738,500
1890	126,095,062	131,937,000			

Most of the world's production of silver is produced or refined in the United States, but a large part of the consumption is that of Great Britain, India, and China, and the price of silver has been dominated by the London market. "Silver, its romance and history," by Benjamin White, contains the following paragraphs relating to the buying and selling of silver and the fixing of the market quotations:

> For several generations four firms have formed the market, namely, Messrs. Mocatta & Goldsmid, Samuel Montagu & Co., Pixley & Abell, and Sharps & Wilkins. The first-mentioned firm dates back to 1684, 10 years before the Bank of England was founded. In the case of the second firm, silver forms but one branch of their business, for they are also foreign bankers. The operation in London, commonly called "fixing" the price of silver, controls the price of the metal in every important financial center throughout the world. This official quotation is cabled abroad instantly by the agency of the press, as well as by each of the four firms, to such of their foreign clients as desire the information. The great bulk of the business transacted is based upon this price, which is determined at a certain hour each day, namely, 1.45 p. m. (Saturday, 11.45 a. m.), by the partners of the respective firms, who meet at the office of one of their number.
>
> Before the demonitization of silver by Germany in 1873 and the great fall in price which followed that event the fluctuations, as well as the volume of business transacted each day, were so small that the operation of "fixing" was carried out by an informal change of notes or by verbal messages. Each broker, while he may disclose the excess of his own position as a buyer or a seller at a given price, is careful to protect in every possible way the interests of his clients and to preserve their anonymity. It should be remembered that it is quite possible for the business done in the market upon a given day to be extremely large, and yet the amount changing hands at "fixing" to be trifling. Clients are therefore well advised to give a discretion to brokers as to the quantity of silver which it is desirable to operate for their account upon any one day. It may be taken for granted that, as a general rule, no silver is parted with at any price before the official quotation is made, but after "fixing" it may occasionally change hands at a lower price if the market is weak, or at a higher if buyers appear after supplies have been absorbed.
>
> The method of fixing the price is very simple. The first step is usually to ascertain if there is occasion to alter the price of the day before. If supplies prove insufficient

to satisfy buying orders, higher prices are suggested until the offerings balance the demand. As a rule, two prices are agreed upon at "fixing," one for a cash delivery, which implies delivery within seven days, at the option of the seller, and the other for delivery in two months' time—that is to say, exactly after two calendar months' interval. A period of two months is selected, because it is found the most convenient interval at which smelters can undertake to deliver the silver which they have purchased in the form of ore. These two periods of delivery—cash and two months—are obligatory as between brokers; but brokers can, as a rule, make arrangements with their clients so as to suit the latter's convenience with regard to shipping, etc. It should be remembered, however, that any request on the part of a client for arrangements differing widely from brokers' rules as between themselves may involve expense to the broker in loss of interest, etc., and also some risk of failure to keep engagements which he has contracted with another broker in order to execute his client's business.

The difference, if any, between the price of forward delivery and that for cash depends upon several circumstances. A strong demand for delivery ahead can carry the forward price to a premium, equal to the loss in interest which would be incurred by paying for the silver at once and holding until the due date; or, on the other hand, an absence of such demand and pressure to sell can bring about a very heavy discount upon the price for silver deliverable within a week. In the former case the premium is limited to the rate of interest, but in the latter case the only check to the amount of discount is the view taken by the market as to the future prospects of silver. This matter of delivery is of extreme importance to all who operate in silver. Sales for forward delivery, appearing safe and reasonable at the time when they are made, may yet involve extremely serious losses to the seller, owing to causes beyond his control. For instance, a smelter may sell 100,000 ounces for delivery in two months, and a strike may break out, or his consignment of ore may be delayed either in shipment or process just when the market happens to be denuded of spot supplies Or a bank may buy a quantity of eastern exchange bills payable in silver, and may sell a quantity of silver as a "hedge." When the paper is redeemed by the drawee in silver, and the bank may desire to buy back the silver, the market may prove unfavorable through circumstances quite beyond its control. Against the risk of such losses may be set off opportunities of gain which may occur. It is possible for dealers in forward silver to obtain a profit by a saving in interest, or on account of an alteration in the relation of the prices fixed for the two deliveries. In other words, a holder of silver for forward delivery may find it advance from a discount to a premium. The existence of a price for forward delivery is necessarily an incentive to speculation, but its chief utility is to afford to smelters, and to the eastern exchange banks, or to merchants connected with China trade, facilities to carry out their legitimate operations. By legitimate it is desired to denote operations which are germane to the discharge of their ordinary commercial business. In normal times cautious speculation in silver is a useful feature of the market. There are sometimes periods when the silver market falls into the doldrums, and acute operators, who may have special means of gauging the situation, are quite justified in taking supplies off the market when it is temporarily overburdened and giving out when it is short of stocks.

The remuneration of brokers consists of one-eighth per cent, which is paid by the buyer. Silver is sold free of charge, and thus only a mere 2s. 6d. per £100 separates the buyer from the seller. As between brokers themselves the brokerage is divided, that is to say, a broker sells to another plus one-sixteenth per cent, and buys from another plus one-sixteenth per cent. Business is done occasionally in "options," which are based, as a rule, on the forward price. Demand for accomodation of this character is fitful, and is usually a symptom of speculative interest. In the ordinary way this method does not enter into the normal business life of the market. The period fixed is usually for two months, but sometimes an arrangement is made for three to six months, rarely for longer. When no wide fluctuations are expected, an option for two months to "call" or "put" silver costs about 2 per cent of the price, plus a brokerage of one-eighth per cent calculated upon the value of the silver. To give a concrete illustration—when the price of silver for forward delivery is fixed at 24d. per ounce standard, and it is desired to buy the "call," or an option of demanding at the end of two months from the date of the contract, £10,000 worth of bar silver at 24d. per standard ounce against payment of £10,000, the outlay would be £208 6s. 8d., plus £12 10s. brokerage. The reverse operation, the "put" or the right to compel the grantor of the option to accept silver at basis price, would cost the same sum.

GOLD AND SILVER AND THE WAR.

It is not surprising that the world's production of gold decreased about $38,500,000 in 1918, but the increase of more than 23,000,000 ounces of silver was very much larger than was expected and was entirely due to the increased output of silver in Mexico.

The full effects of the shortage of labor, the inefficiency of much of the labor available, lack or increased cost of transportation, and high costs of material did not reach a climax until 1918. The world's production of gold will undoubtedly be less in 1919 than in 1918, though the decrease will not likely be so large as it was in 1918. The decreases will not be so pronounced in South Africa or the United States, and there may be small increases in Canada, Mexico and some Central American States.

The world's production of silver will not show much change, for although there will be smaller quantities of silver received from copper ores in the United States, Peru, and some other South American countries and from siliceous ores in the Cobalt district in Canada, the imports into the United States of silver from Mexico for the first six months of 1919 were valued at $5,000,000 more than in the corresponding six months of 1918. On the whole, there is a greater probability of a small decrease in the world's production of silver in 1919 than there is for an increase. When the production of copper becomes more normal and the silver mines now under development become productive, the output of silver will expand in the United States and in Peru. The imports of gold into the United States were much less in 1918 than in 1917 and the total imports only exceeded the exports in 1918 by about $21,000,000. Since the beginning of 1919 there has been a considerable quantity of gold exported to settle trade balances in South America and Asia, and it is evident that active participants in the world war have not any gold other than part of the current output from such producing countries as South Africa and Canada which is available for shipment to the United States.

War demands for silver, because of continued imperative needs in the Orient and because of the large increase in silver coinage to relieve gold currency and to pay armies and workers, steadily increased in 1918. Commercial uses of silver in the arts and most industries, which probably decreased in 1918, have increased considerably in 1919 and the use of silver nitrate has increased enormously, as shown by the increase of more than 10,700,000 fine ounces used in the arts and industries of the United States. In order to stabilize the market for silver the maximum domestic price was fixed on August 1, 1918, at 101¼ cents an ounce; and under the Pittman Act of April, 1918, 350,000,000 silver dollars held in the United States Treasury were made available for remelting into bars and are being utilized by the United States and Allied nations to settle trade balances in India, China, and other large silver-using countries. The quantity of silver required for this purpose was in excess of the total output of silver in the world in 1918, and about 260,000,000 ounces of silver dollars had been remelted up to June 30, 1919, and the refined domestic silver bullion exported in 1918 was valued at $236,411,000. All restrictions on the sale of silver were removed in the United States and Great Britain in May, 1919, and since then the price of silver has fluctuated from $1.05 to $1.30 an ounce, and the average selling price was $1.07 in May, $1.10 in June, and $1.11 in August. It is unwise to venture any prediction as to future prices of silver, but the coining value of an ounce of silver is $1.29+ in the

United States when used in silver dollars and about $1.38 in subsidiary silver coins; and it is quite reasonable to expect that any advance beyond $1.35 an ounce would result in measures to protect the coinage of many nations.

Many operators of gold mines produce ore of such grade that the margin of profit is very small, and that margin depends entirely on the continuous supply and economical treatment of large quantities of ore. The difficulty in obtaining supplies and the decreased efficiency of the miners who could be obtained prevented the usual development in 1917 and 1918. In consequence much of the ore milled in 1917 and in 1918 was that already broken in the mines and kept as a reserve. Prospecting and development of new mines and opening of new ore bodies in working properties have been retarded or altogether suspended. Moreover, some properties have previously successfully mined and treated quantities of low-grade ore by mixing it with ore of higher grade. The higher cost of mining has in many places rendered this course impossible lately, and the higher-grade ore was treated alone. This may result in leaving large quantities of ore which it will not be possible to hoist and mill at a profit in the future.

The gold-mining districts most affected by labor conditions were those adjacent to districts in which base metals were mined, as the products of the base-metal mines were sold at prices which enabled higher wages to be paid than owners of gold mines could afford to pay. Many gold mines have been closed, and at others the best ore bodies are being exhausted at little or no profit.

REPORT OF COMMITTEE ON CONDITION OF GOLD MINING.

The conditions at present hampering the mining of gold and the remedies for such conditions were investigated by organizations of mine owners such as the American Gold Conference, organized at Reno, Nev., in August, 1918, and the International Gold Conference, organized at Spokane, Wash., in September, 1918. It has been generally realized that it has not yet proved feasible to increase the price of gold or to change the quantity of gold in the coinage, but the operators of gold mines suggest that the gold industry can be aided by less revolutionary methods, which will not meet the same opposition. Since the armistice was declared the supply of labor at gold mines has gradually increased and the labor has been more efficient, but there has been little or no reduction in cost of production, because the prices paid for supplies have not materially decreased and costs of transportation have been increased. A report on the causes of the decrease in the production of gold and on the remedies suggested was made to the Secretary of the Interior by a joint committee from the United States Geological Survey and the Bureau of Mines. A summary of the findings of this committee is as follows:

> The findings of the committee appointed in July, 1918, by the Secretary of the Interior to investigate the gold mining situation in the United States, consisting of Hennen Jennings, chairman; J. H. Mackenzie and Charles Janin, of the Bureau of Mines; and H. D. McCaskey and F. L. Ransome, of the United States Geological Survey, are set forth in the accompanying report.
>
> The status of the industry and the conclusions and recommendations of the committee, as presented therein, may be briefly summarized as follows:
>
> Statistics of production dating from the discovery of America in 1492 show that the annual average output was small until 1850, when the discovery of gold in California

and Australia marked the beginning of great gold output. The figures show a slight decline from 1855 to the opening of the mines in the Transvaal in 1887; then there was a very large increase in the yearly output until 1910, since which date there have been irregular fluctuations until 1915, when a serious decline took place.

Though the increase in the output of gold has been rapid during the past 25 years, it has not kept pace with the output of coal, iron, copper, or petroleum, or with the rapid growth of bank deposits.

The present decrease in gold production demands serious consideration, as the maintenance of a sufficient gold reserve is essential to the security of our national finance and credit. The United States is at present the most favored nation in regard to gold reserves, holding over $3,000,000,000, or more than one-third of the gold stock of the world, but it has contracted debts on a gold basis many times that existing before the war.

The principal causes of the decline in gold mining in this country are the shortage of labor and higher wages due to the war, the lower efficiency of available labor, the great increase in the cost of supplies, and the higher cost of power. In addition, the depletion of certain deposits and the lower grade of ore mined in others have contributed to reduction of output.

Bankers and political economists nearly all agree that the gold standard should be maintained in principle.

The war has changed the United States from a debtor nation into a great creditor nation.

Since the outbreak of the war, prices of all commodities have increased greatly except that of gold, which, as the standard of value, is fixed at $20.67+ per ounce. Thus the purchasing power of gold has diminished as the prices of other commodities have risen.

The great increase in the cost of gold mining has discouraged new enterprises and curtailed existing operations. Many mines have been compelled to close and await more favorable conditions. Those mines that have continued operations have been able to do so only by practicing the most rigid economies and by the curtailment of development work. The average operating cost of producing a dollar's worth of gold at the large and most favored quartz mines in 1917 was 70 cents as compared with 57 cents for 1915. Gold mining under present conditions offers little inducement to capital.

Various means of stimulating the production of gold in the United States have been proposed. The committee reports on them as follows:

Payment by the Government of a bonus on newly mined gold has many advocates. The committee does not believe that the granting of a bonus would be beneficial at this time.

The United States Employment Service can, if properly authorized, be of great help in diverting labor to the gold industry. Gold mining has been officially declared an essential industry, and in the opinion of the majority of the committee should rank in this respect with other preferred industries. Exemption from draft and deferred classification of gold labor has already been granted to a certain extent by the War Department.

The furnishing of supplies to gold mines at pre-war or cut prices does not seem to be feasible.

The elimination of the excess-profits tax on gold mining, and the encouragement of a maximum output thereby might result in larger revenues than with the tax standing, as larger dividends paid to share holders would mean greater revenue for general taxation. As the profits of a gold mine, no matter how large, can not be ascribed to war conditions, but on the contrary are diminished by them, the remission of this tax is just and logical.

Gold mining as an essential industry is entitled to preferred classification for railroad freight, etc., and should receive the benefit of any modification of freight rates granted any other preferred industry.

When electric power is used gold mines should have a high-class rating with regard to power consumption, and power should be curtailed only when necessary.

The privilege of free export and of sale to manufacturers would stimulate production, and might also be a safeguard against inflation. The committee recommends the removal of restrictions on the export and sale of gold.

The committee suggests that gold and other mining companies might properly be required by law to furnish to the Government, with such frequency as may be desirable, statistics of their costs, production, and profits, and these should be available for publication.

The Government should, through the Bureau of Mines, assist in improving methods of mining and metallurgy of gold ores, particularly in the treatment of complex and low-grade ores. A wide field of work is presented here.

Some aid in reducing costs might be obtained by cooperative buying of supplies by mining companies through central agencies in each State or district, but the organization of a general system of cooperative buying would be very difficult.

Possible methods of maintaining the visible gold reserve, apart from mine production, are: (1) The curtailment of the use of gold for manufactures, and (2) making a call on the public to turn in hoarded gold. In France voluntary contributions by the populace since the war began have amounted to more than 2,000,000,000 francs.

Further relief might be obtained by amending the war-minerals bill to include gold and voting an appropriation to be used in directing the search for new deposits.

The findings of the committee did not give any present tangible relief to the producers of gold, and it is reported that further efforts will be made under the direction of the mining congress to bring about legislation by Congress which will relieve the burden now imposed on them by advanced costs and a stationary value of their product, and yet prevent tampering with the standard of international monetary systems. John Clausen, vice president of the Chemical National Bank, New York City, has suggested[1] that gold be withdrawn from circulation and used solely to support credit, bringing gold mines under Government supervision to insure the delivery of an appreciable part of the gold produced at the standard fixed price of $20.67 a fine ounce. The remainder of the gold produced, which would be available for use in arts and industries would be sold at a price of $40 to $45 an ounce so that the net selling price of all the gold from mines would average about $30 an ounce and thus offset the much increased cost of labor and materials. It is argued that the arts and industries could readily absorb the increased cost of gold, that there would be no radical reduction in the output of the trades that use gold, and that such increased cost would be a tax mainly on luxuries. The proposal has some merit, for certainly the very largely increased price of articles made from platinum has not resulted in any lessening in the demand. The sales of diamonds and jewelry have also increased with advanced prices. To put such a plan into effective operation, however, would require an act of Congress imposing very stringent penalties for defacing or using gold coins and for selling new gold and gold scrap and wastes to others than the Government. There would also have to be careful supervision to prevent the smuggling of foreign gold, for considerable quantities of foreign gold have always eluded the customs officials, and the proposed bonus would be a great incentive for illicit traffic.

It is apparent that conditions imposed by the World War are responsible for much of the decrease in the production of gold, but in the United States there have been contributing causes which are more fully discussed in the separate State chapters of Mineral Resources for 1917 and 1918 that relate to gold, silver, copper, lead, and zinc.

MINES REPORT.

METHOD OF COLLECTING STATISTICS.

The first table in this report presents the final official figures of the production of gold and silver in the United States in 1918 as agreed upon by the Bureau of the Mint and the United States Geological Survey. With the comparatively unimportant exceptions of domestic gold and silver contained in ores and mattes exported for reduction during the year, these figures record the actual production of gold and silver bullion from domestic ores in marketable form as metals, either refined or unrefined.

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[1] Saturday Evening Post, Oct. 11, 1919.

Owing to the difficulty of tracing this total gold and silver production back to its origin by States, counties, and mining districts, however, the Geological Survey attacks this problem of distribution by systematic investigation of the mine production of ores containing gold and silver during the calendar year and of the output of the placer mines. In this way the state of the mining industry is studied in detail, and the output is classified by methods of production and by kinds of ore, as well as by mining districts. The resulting figures form the basis of the mines reports.

Of the two plans outlined for ascertaining the gold and silver production of the United States it may be said that one is a measure of the mining industry and the other a measure of the metallurgic industry; that one reports the mine output and its recoverable content and the other the metal actually recovered in marketable form. The two methods will not produce exactly corresponding results, nor should they be expected to do so.

The figures of the reports of the mint and of the mines reports for a period of years sufficiently long to compensate for overlap or lag should agree within allowable limits of error due to the complexity of the problem involved.

For the last 14 years in which complete statistics have been gathered by both methods the final figures have been as follows:

Gold and silver produced in the United States, 1905–1918, according to Mint and to mine returns.

Year.	Mint.		Mine.	
	Gold.	Silver.	Gold.	Silver.
		Ounces.		*Ounces.*
1905	$88,180,700	56,101,600	$88,159,881	56,272,496
1906	94,373,800	56,517,900	97,219,645	57,362,455
1907	90,435,700	56,514,700	87,471,186	52,500,104
1908	94,560,000	52,440,800	91,914,891	50,878,140
1909	99,673,400	54,721,500	99,438,144	57,315,677
1910	96,269,100	57,137,900	94,933,778	57,598,509
1911	96,890,000	60,399,400	97,054,791	61,108,791
1912	93,451,500	63,766,800	92,880,467	66,041,506
1913	88,884,400	66,801,500	89,987,888	71,200,237
1914	94,531,800	72,455,100	92,703,757	69,633,769
1915	101,035,700	74,961,075	99,605,314	72,368,878
1916	92,590,300	74,414,802	92,822,430	78,875,176
1917	83,750,700	71,740,362	82,032,745	70,665,531
1918	68,646,700	67,810,139	67,701,936	68,063,090
	1,283,273,800	885,783,578	1,273,926,803	889,884,359

These figures show, according to Mint reports, a total excess of gold for the 14 years of $9,346,997, or a difference of about 0.7 per cent, and a total deficit of silver of only 4,100,781 ounces, or a difference less than 0.5 per cent. The figures for Alaska placers are not considered to be so closely approximate as the total figures for gold, hence the differences for the United States proper are probably even lower. It is thought that those small differences are fully accounted for in the detailed discussions of the subject in previous reports of this series. For figures of any one year an excess of mining over smelting and refining is indicated by larger returns in the mines reports for gold or silver, or both, and opposite relations of excess of smelting and refining and drawing upon stocks are indicated by larger returns in the Mint report.

UNITS OF MEASUREMENT.

In measurement of ores and concentrates the short ton of 2,000 pounds is used throughout. The price of gold is fixed by law at $20.67+per fine ounce. The annual average prices for silver from 1865 to 1917, inclusive, based on the equivalent New York value of a fine ounce with exchange at par, are given elsewhere in this report. (See p. 729.) The average price for silver in 1918 is that given by the Bureau of the Mint as the approximate actual selling price of all silver sold. The average commercial prices (or dealers' prices) for silver 0.999 fine at New York are those quoted from day to day on the market and run uniformly somewhat below the prices as given elsewhere by years.

PRODUCTION OF GOLD AND SILVER REPORTED FROM THE MINES.

The following table gives the quantity and value of the output of recoverable gold and silver ("mine production") by States reported from the producing mines in 1918 to the United States Geological Survey. The increase or decrease of production shows results by comparison with the corresponding Geological Survey mine figures for 1917.

Mine production of gold and silver in the United States in 1918.

State or Territory.	Gold.		Silver.		Increase or decrease.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces.).	Value.	Gold.	Silver (fine ounces).
Alabama	38.55	$797	2	$2	− $1,465	− 9
Alaska	458,641.05	9,480,952	847,789	847,789	− 5,176,401	− 391,361
Arizona	262,919.43	5,435,027	6,686,152	6,686,152	+ 366,834	− 297,761
California	799,588.10	16,528,953	1,427,711	1,427,711	− 3,558,551	− 347,720
Colorado	616,864.36	12,751,718	7,063,554	7,063,554	− 2,977,506	− 240,799
Georgia	285.07	5,893	25	25	− 996	− 21
Idaho	33,998.72	702,816	9,172,340	9,172,340	− 101,993	− 2,856,998
Illinois	....	....	8,171	8,171	....	+ 985
Maryland, Maine, New Hampshire, New York, and Vermont	37.01	765	11,107	11,107	+ 628	+ 9,398
Michigan	....	....	509,467	509,467	....	− 179,084
Missouri	....	....	46,939	46,939	....	− 14,647
Montana	150,192.96	3,104,764	16,797,479	16,797,479	− 412,489	+ 3,669,337
Nevada	320,239.45	6,619,937	10,000,599	10,000,599	− 339,531	− 1,269,370
New Mexico	33,030.02	682,791	782,421	782,421	− 381,367	− 611,944
North Carolina	78.90	1,631	17	17	− 10,556	− 1,093
Oregon	61,458.74	1,270,465	107,323	107,323	− 221,333	− 18,333
Philippine Islands	62,403.75	1,290,000	4,138	4,138	− 118,161	+ 119
Porto Rico	4.84	100	....	....	....	....
South Carolina	....	....	....	....	− 1,083	− 3
South Dakota	317,596.18	6,565,337	159,202	159,202	− 798,896	− 27,563
Tennessee	235.39	4,866	93,620	93,620	− 460	− 5,433
Texas	1.21	25	576,565	576,565	+ 3	− 19,224
Utah	142,666.10	2,949,170	13,455,597	13,455,597	− 405,986	− 23,536
Virginia	19.35	400	1,814	1,814	− 943	− 2,704
Washington	14,737.83	304,658	310,093	310,093	− 187,666	+ 27,773
Wyoming	42.14	871	965	965	− 2,891	− 2,450
	3,275,081.15	67,701,936	68,063,090	68,063,090	−14,330,809	− 2,602,441
Increase or decrease in value	....	....	....	....	−14,330,809	+$9,834,692

A decrease in production of gold from mines of the United States of $14,330,809 is shown for 1918, following a decrease of $10,789,685 in 1917 and of $6,782,884 in 1916. A decrease of 2,602,441 ounces of silver is shown, following a decrease of 8,209,645 ounces in 1917.

The principal gold-producing States ranked as follows in 1918: California, Colorado, Alaska, Nevada, South Dakota, and Arizona, and these six States together made 85 per cent of the total output. The only notable increase was Arizona, which produced about $367,000 more in 1918 than in 1917. The most notable decrease in gold was $2,977,506 in Colorado, $5,176,401 in Alaska, $405,986 in Utah, $798,896 in South Dakota, $3,558,551 in California, and $412,489 in Montana. Every State that yielded more than $1,000 in gold, with the exception of Arizona, had a decreased output in 1918.

The principal silver-producing States in 1918 in order of output were Montana, Utah, Nevada, Idaho, Colorado, and Arizona, and these six States together produced 93 per cent of the total for the United States. The only large increase in 1918 was 3,669,337 ounces in Montana and only five States had an increased output. There was large decrease in output of silver—1,269,370 ounces in Nevada, 2,856,998 ounces in Idaho, 611,944 ounces in New Mexico, 347,720 ounces in California, 240,799 ounces in Colorado, 297,761 ounces in Arizona, and 391,361 ounces in Alaska.

About $34,200,000, or more than half of the entire output of gold in the United States in 1918, was produced by 25 companies. The largest producer was the celebrated Homestake mine in South Dakota. Sixteen of the larger properties produced the gold from dry or siliceous ores, four produced it from gravels by dredging, four recovered the gold in the treatment of copper ores, and one from lead ores. Exclusive of the output of gold of the large producing operators, about $33,500,000 came from the operation of more than 6,000 placer and deep mines, many of which produced between $100,000 and $400,000 each. Hundreds of mines, especially placer properties in California, Oregon, Idaho, Alaska, Arizona, and the Appalachian States, yielded very small quantities of gold, and the average production of the smaller mines was less than $6,000.

Larger producers of gold in the United States in 1918 in order of output.

Rank.	Operator.	State.	Mining district.	Source of gold.
1	Homestake Mining Co	South Dakota	Whitewood	Dry or siliceous ores.
2	Yuba Consolidated Goldfields	California	Marysville	Dredging gravels.
3	Portland Gold Mining Co	Colorado	Cripple Creek	Dry or siliceous ores.
4	Cresson Consolidated Mining Co	do.	do.	Do.
5	United Eastern Mining Co	Arizona	Oatman	Do.
6	Natomas Company of California	California	Oroville and Folsom	Dredging gravels.
7	Empire Mines	do.	Grass Valley	Dry or siliceous ores.
8	Vindicator Consolidated Gold Mining Co.	Colorado	Cripple Creek	Do.
9	Chichagoff Mining Co	Alaska	Sitka	Do.
10	Anaconda Copper Mining Co	Montana	Summit Valley	Copper ores.
11	Utah Copper Co	Utah	West Mountain	Do.
12	Alaska Gastineau Mining Co	Alaska	Juneau	Dry or siliceous ores.
13	Liberty Bell Gold Mining Co	Colorado	Upper San Miguel	Do.
14	Argonaut Mining Co	California	Grass Valley	Do.
15	Goldfield Consolidated Mines Co	Nevada	Goldfield	Do.
16	North Star Mines	California	Grass Valley	Do.
17	Tom Reed Gold Mines Co	Arizona	Oatman	Do.
18	Plymouth Consolidated Mining Co.	California	Mother Lode	Do.
19	Marysville Dredge Co	do.	Marysville	Dredging gravels.
20	Tomboy Gold Mines Co	Colorado	Upper San Miguel	Dry or siliceous ores
21	Barnes King Mining Co	Montana	Ottawa	Do.
22	United Verde Copper Co	Arizona	Verde	Copper ores.
23	Calumet & Arizona Mining Co	do.	Turquoise	Do.
24	Yukon Gold Co	Alaska	Ruby and Iditarod	Dredging gravels.
25	United States Mining Co	Utah	West Mountain	Lead ores.

The largest output of silver was that of the Anaconda Copper Mining Co. from copper ores. The Chief Consolidated Mining Co., of Utah, which had the second largest output of silver, derived the silver from lead ores; and the Butte & Superior Mining Co., the third largest producer, derived the silver from lead-zinc ores. The Tonopah Mining Co., which held eighth place, was the largest producer from siliceous ores. Seven of the 25 mines enumerated recovered silver from copper ore, 11 from lead ore, 5 from dry or siliceous ore, and 2 from zinc-lead ore. Several mines yielded more silver than the Presidio mine in Texas, but it was the largest producer of silver from ore that contained no appreciable quantity of any other metal. The approximate output of the 25 properties was 36,250,000 ounces, or about 53 per cent of the total production of silver in the United States in 1918.

Larger producers of silver in the United States in 1918, in order of output.

Rank.	Operator.	State.	Mining district.	Source of silver.
1	Anaconda Copper Mining Co	Montana	Summit Valley	Copper ores.
2	Chief Consolidated Mining Co	Utah	Tintic	Lead ores.
3	Butte & Superior Mining Co	Montana	Summit Valley	Lead-zinc ores.
4	Hercules Mining Co	Idaho	Leland	Lead ores.
5	Hecla Mining Co	do	do	Do.
6	Tintic Standard Mining Co	Utah	Tintic	Do.
7	United Verde Copper Co	Arizona	Verde	Copper ores.
8	Tonopah Mining Co	Nevada	Tonopah	Dry or siliceous ores.
9	Tonopah-Belmont Development Co.	do	do	Do.
10	Bunker Hill & Sullivan Mining Co.	Idaho	Yreka	Lead ores.
11	Tonopah Extension Mining Co	Nevada	Tonopah	Dry or siliceous ores.
12	Calumet & Arizona Mining Co	Arizona	Warren	Copper ores.
13	North Butte Mining Co	Montana	Summit Valley	Do.
14	Federal Mining & Smelting Co	Idaho	Hunter	Lead ores.
15	Ontario Silver Mining Co	Utah	Uintah	Do.
16	Tamarack & Custer Consolidated Mining Co.	Idaho	Leland	Do.
17	West End Consolidated Mining Co.	Nevada	Tonopah	Dry or siliceous ores.
18	Elm Orlu Mining Co	Montana	Summit Valley	Lead-zinc ores.
19	Kennecott Copper Co	Alaska	Chitina	Copper ores.
20	Caledonia Mining Co	Idaho	Yreka	Lead ores.
21	Davis Daly Copper Co	Montana	Summit Valley	Copper ores.
22	United States Mining Co	Utah	West Mountain	Lead ores.
23	Copper Queen Consolidated Mining Co.	Arizona	Warren	Copper ores.
24	Utah Apex Mining Co	Utah	West Mountain	Lead ores.
25	Presidio Mining Co	Texas	Shafter	Siliceous (silver) ores.

MINE PRODUCTION OF GOLD AND SILVER, BY STATES.

ALASKA.

It is estimated that the total production of gold in Alaska from earliest mining, in 1880, to the end of 1918 has been $302,238,961, of which $213,042,992 has come from placers. The total production of silver has been 8,389,308 fine ounces, of which 5,327,852 ounces was recovered from copper ores and 1,741,567 ounces from the refining of placer gold.[1]

Gold.—The mine production of gold in Alaska in 1918 was $9,480,952, or about $5,170,000 less than that of 1917. The yield from siliceous ores decreased from $4,581,453 in 1917 to $3,473,317 in 1918; the yield from copper ores decreased from $265,900 in 1917 to $107,635 in 1918; the placer output in 1918 was $5,900,000, against

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[1] U. S. Geol. Survey Mineral Resources, 1918, pt. 1, pp. 127-128, 1919.

$9,810,000 in 1917. Twenty-eight dredges produced $1,425,000 of the placer gold, which was $1,075,000 less than the yield from dredging in 1917.

Of the productive gold lode mines, 6 were in southeastern Alaska, 3 on Prince William Sound, 4 in Kenai Peninsula, 5 in Willow Creek district, and 6 in Fairbanks district. The 6 deep gold mines in southeastern Alaska yielded more than 90 per cent of the gold derived from siliceous ores.

The 2,095,573 tons of siliceous ores treated in 1918 yielded an average of $1.70 in gold and silver a ton, and the 722,047 tons of copper ore contained $1.07 in gold and silver a ton and had a copper content of 4.8 per cent.

Nearly 37 per cent of the total output of gold in Alaska came from gold lode mines in 1918, against 31 per cent in 1917, 34 per cent in 1916, 36 per cent in 1915, 31 per cent in 1914, 31 per cent in 1913, and 29 per cent in 1912. The 727 placers operated in 1918 yielded approximately 4,931,000 cubic yards of auriferous gravel, of which the dredges handled about 2,490,000 cubic yards and made an average recovery of 57 cents a cubic yard in 1918, against 68 cents a yard in 1917, 69 cents a yard in 1916, 51 cents a yard in 1915, and 53 cents a yard in 1914.

The estimated total recovery of gold by dredging for the period 1903–1918, inclusive, is $19,035,000.

No important new placer-bearing areas were reported in 1918.

Silver.—The mine production of silver in Alaska in 1918 was 847,789 fine ounces, against 1,239,150 ounces in 1917. The copper mines produced 719,391 ounces—a decrease of 321,762 ounces; the siliceous ores yielded 90,064 ounces in 1918, against 133,587 ounces in 1917; and the placers yielded 38,334 ounces in 1918, against 64,410 ounces in 1917.

ARIZONA.

Gold.—The mine production of gold in Arizona in 1918 was $5,435,027, which was $366,834, or about 7 per cent, more than in 1917. Placers contributed only $4,234, which came from small mines in Yuma, Pima, Maricopa, and Yavapai counties. The deep mines produced $5,430,793, of which 57 per cent came from dry or siliceous ores mined chiefly in Mohave, Yavapai, and Cochise counties, and 41 per cent was contained in copper ores mined chiefly in Cochise and Yavapai counties. Mohave County had a gold output of $2,798,903, an increase of more than $335,000, Cochise County produced $1,108,685, and Yavapai County $1,117,701. The gold recovered from ores treated at gold and silver mills represented 53 per cent of the total output, against 49 per cent in 1917, and crude ores shipped to smelters contained nearly 39 per cent. The crude copper ores mined and smelted directly (without previous concentration) contained an average gold content of 49 cents a ton.

Silver.—The mine production of silver in Arizona decreased from 6,983,913 fine ounces in 1917 to 6,686,152 ounces in 1918. Of this production 5,347,618 ounces came from copper ores, 917,973 ounces from dry or siliceous ores, 362,182 ounces from lead ores, 36,208 ounces from lead-zinc ores, and smaller quantities from zinc, copper-zinc, and copper-lead ores. Cochise County produced 2,315,518 ounces in 1918, of which 1,693,598 ounces came from copper ores and 426,019 ounces from siliceous ores. The silver output of Yavapai County, which increased from 2,207,583 ounces in 1917 to 2,502,968 ounces in 1918, was mainly derived from copper ores. Bullion recovered from gold and silver ores, almost all by cyanidation, yielded 158,476 ounces of silver. Concentrates contained 1,109,510 ounces, and crude ore shipped to smelters contained 5,372,505 ounces, or 80 per cent of the total output of silver.

CALIFORNIA.

Gold.—The mine production of gold in California in 1918 was $16,528,953. The decrease of $3,558,551 was mainly due to a smaller production from deep-mine operations.

In 1918 the deep mines produced $8,690,174 (a decrease of $2,323,300), of which gold-quartz ores yielded 91 per cent and copper ores 3.9 per cent. California placers in 1918 produced $7,838,779 in gold, or $1,235,251 less than in 1917. Of the placer production $7,431,927 was recovered by dredging. The total dredge production from 1896 to the end of 1918 has been $102,625,912, and the yield of gold by dredges was equal to 45 per cent of the total yield of gold for 1918. The Yuba County dredges, 12 in number, made the largest output of gold, the value being $3,750,033, an increase of $90,822. Sacramento County, with 10 dredges working, made an output of $1,690,279—a decrease of $223,225. In Butte County (including Oroville and other districts) 7 dredges produced $626,016 in gold, or $272,125 less than in 1917. Dredges were also operated in Calaveras, Amador, Merced, Stanislaus, Placer, Shasta, Siskiyou, San Joaquin, and Trinity counties.

Four of the 29 counties in California which reported mine production of gold had a yield of more than $1,000,000 in 1918, as follows: Nevada, $3,070,453; Amador, $3,249,385; Yuba, $3,767,933; Sacramento, $1,694,724. Of these Yuba and Sacramento counties obtained most of their gold by dredging, Amador is on the Mother Lode, and Nevada County produced mainly from siliceous ores of the Grass Valley district. The five Mother Lode counties—Amador, Calaveras, Eldorado, Mariposa, and Tuolumne—whose output is mainly gold milling ores, produced $2,657,624 in gold from mill bullion and $1,614,455 from concentrates in 1918, against a recovery of $3,202,212 from mill bullion and $1,888,961 from concentrates in 1917.

Silver.—The mine production of silver in California in 1918 was 1,427,711 fine ounces—a decrease of 347,720 ounces. About 47 per cent of the output, or 669,711 ounces, came from the copper ores. Siliceous ores yielded 228,332 ounces, silver-lead ores, zinc ores, and lead ores 499,759 ounces, and placers the remainder. The only counties producing more than 100,000 ounces of silver in 1918 were Shasta, Plumas, and Inyo. About 69 per cent of all the silver was recovered from crude ores sent to smelters.

COLORADO.

Gold.—The total mine production of gold in Colorado in 1918 was $12,751,718, a decrease of $2,977,506, following a decrease in 1917 of $3,424,597. The Cripple Creek district, with a decrease of $2,275,100, produced $8,119,747 in gold, which was 64 per cent of the State output of gold from all sources, and San Miguel district produced $2,127,634 in gold in 1918, as against $2,009,961 in 1917.

During 1918 the Roosevelt tunnel was completed and connected with the Portland No. 2 shaft at a depth of 2,131 feet from the surface. The main drainage tunnel, work on which was commenced 11 years ago, is 24,255 feet in length from its portal to heading.

The San Juan region, in Dolores, La Plata, Ouray, San Juan, and San Miguel counties, produced $2,502,804; Lake County yielded $843,239, a decrease of $331,980; and there were also decreases in Boulder, Clear Creek, Gunnison, Gilpin, La Plata, Park, Chaffee, San Juan, and Summit counties. Siliceous and dry ores, which amounted to 76 per cent of all the ore sold or treated, yielded 92 per cent of the total output of gold. Slightly less than 3 per cent came from lead ore, 4 per cent from placers, about 1 per cent from lead-zinc ore, and the remainder from other classes of ore. The placer production in 1918 was $526,202, a decrease of $134,826. Summit County produced 82 per cent and Lake County nearly 18 per cent of the placer gold. Dredges in these two counties recovered more than 99 per cent of the placer gold.

Silver.—The mine production of silver in Colorado in 1918 was 7,063,554 fine ounces, a decrease of 240,799 ounces. Lake County, principally Leadville, produced 2,290,121 ounces, an increase of 106,121 ounces. San Miguel County produced 836,570 ounces, an increase of 57,200 ounces. There was larger production of silver from Custer, Eagle, Gilpin, Hinsdale, Mineral, and San Miguel counties, and decreased output from Boulder, Chaffee, Clear Creek, Gunnison, Pitkin, and San Juan counties. Siliceous and dry ores yielded 67.3 per cent of the silver recovered, lead ores 20.6 per cent, lead-zinc ores 8 per cent, and copper ores 2.4 per cent. The remainder came from placers, zinc ores, and copper-lead ores.

IDAHO.

Gold.—The mine production of gold in Idaho in 1918 was $702,816, a decrease of $101,993. The total production of gold from Idaho from the discovery of placer gold in 1863 to the end of 1918 is estimated at $131,613,785 by C. N. Gerry.[1]

Boise and Shoshone counties were the largest producers of gold in 1918 and yielded about 67 per cent of the total output. The lode mines produced gold valued at $426,406. The placer mines produced $276,410 in gold in 1918, of which $239,762 was won by dredging. The total output of gold recovered by dredges from 1897 to the end of 1918 has been $4,021,265. Of the total gold in 1918 about 39 per per cent came from placers, 42 per cent from siliceous ores, 10 per cent from copper ores, and the remainder from lead and lead-zinc ores.

Silver.—The mine production of silver in Idaho in 1918 was 9,172,340 fine ounces, or 2,856,998 ounces less than in 1917. The total yield of silver from Idaho for the period 1863 to 1918, inclusive, is 233,878,295 fine ounces.[1]

There was a decrease of 26 per cent in the output of silver from Shoshone County, which yielded 92.1 per cent of the total quantity of silver in 1918, 93.4 per cent in 1917, 95 per cent in 1916 and 1915, and 98 per cent in 1914. Lead ores contained 88 per cent of the output of of silver and lead-zinc ores 9 per cent. Crude ore shipped, which averaged 15.61 ounces of silver a ton, supplied nearly 32 per cent of the silver, and concentrates, which averaged 19.66 ounces of silver a ton, contained nearly 68 per cent of the total silver. Inability to handle and smelt all the ores mined had the effect of curtailing the production of silver.

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[1] U. S. Geol. Survey Mineral Resources, 1918, pt. 1, p. 461.

MAINE, PENNSYLVANIA, NEW HAMPSHIRE, NEW YORK, AND VERMONT.

A small quantity of gold and about 11,107 ounces of silver were obtained from copper ores and old slag shipped from the Pike Hill, Ely, and Elizabeth mines in Vermont, the Douglas mine at Blue Hill in Maine, and from zinc-lead ore containing silver shipped from the Silver Lake mine in Carroll County, N. H., and a few tons of silver-bearing galena shipped from Sullivan County, N. Y., by the Summitville Ore Concentrating Co.

MICHIGAN.

Silver.—The copper mines of Michigan produced 509,467 fine ounces of silver in 1918, against 688,551 fine ounces of silver in 1917. The silver was mainly derived from the electrolytic treatment of 56,127,000 pounds of copper. The average recovery of silver per ton of "rock" treated was 0.18 ounce a ton. Of the total output of silver 453,957 ounces came from mines in Houghton County.

MISSOURI, OKLAHOMA, ILLINOIS, AND KENTUCKY.

Silver.—The lead and zinc mines of the Central States produce no gold and only a comparatively small quantity of silver. Nearly all the silver is a by-product from the refining of lead from concentrates of lead ores mined in southeastern Missouri. The total yield of silver from Missouri in 1918 was 46,939 fine ounces, which, with the exception of 7,892 ounces recovered from copper ore and copper concentrates, was derived from lead recovered from 52,000 tons of galena concentrates. The average recovery was slightly more than 0.75 ounce of silver per ton of concentrate smelted.

The lead-zinc fluorspar deposits of the Kentucky-Illinois field carry silver, and from the lead concentrates shipped from Illinois in 1918, a recovery of 8,171 ounces was recorded, against 7,186 ounces in 1917. The average silver content per ton recovered from lead concentrates from Illinois in 1918 was 6.65 ounces. No silver ore was shipped from the Criswell mine, near Byars, McClain County, Okla., in 1918.

MONTANA.

Gold.—The mine production of gold in Montana decreased from $3,517,253 in 1917 to $3,104,764 in 1918. The placer yield was $396,232—a decrease of $70,831. Silver Bow County had the largest total output—$902,094. Most of the placer gold was recovered by one company, which operated three dredges in Alder Gulch, in Madison County. Lewis and Clark County produced $634,497, and Deer Lodge County $453,083, chiefly from siliceous ores. At amalgamation and cyanidation plants $930,309 in gold was produced, or an average recovery of $5.32 per ton of ore and tailings treated. Ore treated at concentration mills yielded concentrates containing $894,481, or 44 cents a ton, and crude ore shipped to smelters contained $828,329 in gold, or an average of $1.73 a ton.

Silver.—Montana mines produced 16,797,479 fine ounces of silver in 1918, a production nearly 28 per cent more than in 1917. The copper ores yielded 10,521,219 ounces (an average of 1.64 ounces per ton), of which Silver Bow County (Butte) supplied 10,480,556 ounces. The lead-zinc ores produced 4,532,034 ounces, of which Silver Bow County supplied 4,261,041 ounces. The dry or siliceous ores produced 1,028,443 ounces, of which Granite County supplied 465,631 ounces and Silver Bow County 269,673 ounces.

NEVADA.

Gold.—The mine production of gold in Nevada in 1918 was $6,619,937, against $6,959,468 in 1917. The production in 1918 from mines in Esmeralda County was $1,361,321—a decrease of nearly $625,000. The Goldfield district yielded $1,212,572 in gold in 1918, against $1,900,082 in 1917. Nye County produced $1,991,845, of which Tonopah yielded $1,287,745—a decrease in Tonopah of more than $250,000. The counties having a substantial increase in gold were Elko, Storey, and Lyon. Sixty-six per cent of the decrease in output of gold was due to smaller yield from Goldfield and Tonopah.

Silver.—There was a decrease in the mine production of silver in Nevada in 1918, the total being 10,000,599 fine ounces, against 11,269,969 ounces in 1917. Nye County (almost wholly from the Tonopah district) again led in output with 6,104,711 ounces, which was about 1,068,000 ounces less than in 1917. Humboldt County, with 869,662 ounces, Churchill County, with 625,152 ounces, and Lincoln County, with 421,310 ounces, were the other counties which had an output exceeding 400,000 ounces. Dry or siliceous ores yielded all but 848,223 ounces of the output of silver, and 88 per cent of this yield was recovered by cyanidation.

NEW MEXICO.

Gold.—The mine production of gold in New Mexico in 1918 was $682,791, against $1,064,158 in 1917, $1,382,480 in 1916, and $1,461,105 in 1915. Mills in the Mogollon district, Socorro County, produced only $119,710, against $258,620 in 1917; Grant County, $270,052; and Colfax and Lincoln counties, $274,273.

Copper ores, chiefly from Grant County, contained $241,830, and dry and siliceous ores yielded $426,275. The output from other kinds of ore was very small and the placer output was only $3,118.

Silver.—The mine production of silver in New Mexico decreased from 1,394,365 fine ounces in 1917 to 782,421 ounces in 1918. Socorro County produced 352,878 fine ounces, or about 45 per cent, chiefly from siliceous ores from the Mogollon district, the remainder from mixed ores of the Magdalena district. The output of silver from Grant County decreased from 487,558 fine ounces in 1917 to 338,833 ounces in 1918, and most of this yield came from the Lordsburg and Central districts. Dry and siliceous gold and silver ores, chiefly from Grant and Socorro counties, yielded 48 per cent of the total; copper ores, chiefly from Grant, Socorro, and Santa Fe counties, yielded 32 per cent. The remainder of the production was from lead, lead-zinc, and copper-lead ores, mainly from the Central, Cooks Peak, Victorio, and Magdalena districts.

OREGON.

Gold.—The mine production of gold from Oregon decreased about 15 per cent, being $1,270,465 in 1918, against $1,491,798 in 1917. The output in 1916 ($1,902,179) was the largest recorded by the Survey for 13 years preceding 1916. The decrease in 1918 was due to the placer mines, which yielded only $498,249, or $229,117 less in 1918 than in 1917. Eighty-nine per cent of the output from deep mines was from siliceous ores. The deep mines of the State produced $772,216, an increase of $7,784. The two dredges in Baker County and one dredge in Grant County produced $387,740, and a few drift mines, hydraulic, and surface placers in Baker, Jackson, Curry, Douglas, Crook, Josephine, and Malheur counties produced the remainder of the placer gold. Baker County, with a yield of $1,009,656, and Grant County with a yield of $101,981, were the only counties which produced more than $100,000 in gold.

Silver.—The mine production of silver in Oregon in 1918 was 107,323 fine ounces—a decrease of 18,333 ounces. Of the total production 77,031 ounces came from siliceous ores, 26,161 ounces from copper ores, and 4,102 ounces from placer bullion.

SOUTH DAKOTA.

The total value of the production of gold in South Dakota from 1876 to the end of 1918 is given by Charles W. Henderson, of the United States Geological Survey, as $214,084,159, and the total output of silver for the same period as 6,593,705 fine ounces.[1]

Gold.—The mine production of gold in South Dakota in 1918 was $6,565,337, against $7,364,233 in 1917. The output was almost wholly from siliceous milling ores of low grade, of which more than 63 per cent was recovered by amalgamation and the remainder by cyanidation. The Homestake mines and mills were operated continuously to October 27, 1918, and at 71 per cent of capacity for the remainder of the year and produced $5,916,890 in bullion from 1,628,630 tons of ore treated. The Mogul and Trojan mills were also operated steadily. The small yield of placer gold (21 ounces), came from Lawrence and Pennington counties.

Silver.—The mine output of silver, derived mainly from refining the gold bullion produced, was 159,202 fine ounces, or 27,563 ounces less than in 1917.

SOUTHERN APPALACHIAN STATES.

The total production of gold from 1799 to the end of 1918 in the southern Appalachian States, as shown from data compiled by the Bureau of the Mint and the United States Geological Survey, has been $51,020,931. The figures credit Alabama with $766,336, Georgia with $17,823,769, North Carolina with $23,628,413, Tennessee with $253,010, Virginia with $3,296,569, South Carolina with $5,181,429, and Maryland with $71,405.

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[1] U. S. Geol. Survey Mineral Resources, 1918, pt. 1, p. 184, 1919.

Gold.—The combined mine production of gold in the southern Appalachian States in 1918 was $13,587, against $29,156 in 1917. Georgia led with $5,893; Tennessee was next with $4,866; North Carolina, $1,631; Alabama, $797; Virginia, $400. The gold produced in Tennessee was from copper ores of the Ducktown district. The production of gold from 17 placers amounted to $6,591. Copper ores mainly from Tennessee and Virginia yielded about 255 ounces of gold, and siliceous ores from Alabama and Georgia yielded only 84 ounces in 1918.

Silver.—Copper ores in Tennessee and Virginia yielded 95,434 ounces of silver and siliceous ores and placer bullion only 44 ounces.

TEXAS.

Gold.—The total output of gold from Texas mines from 1885 to the end of 1918 is given by Charles W. Henderson as $43,582.[1]

The yield of gold has been very small and has been mainly a by-product. The output of gold increased from $22 in 1917 to $25 in 1918.

Silver.—The total production of silver in Texas from 1885 to 1918, inclusive, has been 14,243,691 ounces, according to Henderson.[1]

The mine production for 1918 was 576,565 fine ounces, against 595,789 ounces in 1917. The greater part of the silver continued to come from the Presidio silver mine and cyanidation mill in the Shafter district, Presidio County. The silver contained in copper ores shipped in 1918 amounted to 57 ounces, and that in lead ores to 6,943 ounces.

UTAH.

Gold.—The total output of gold in Utah from 1864 to 1918, inclusive, is given by V. C. Heikes, of the United States Geological Survey, as $96,068,503.[2]

The mine production of gold decreased from $3,355,156 in 1917 to $2,949,170 in 1918. The largest part of the gold was contained in ores produced in Salt Lake County, and amounted to $2,083,254. Juab County ranked next with $628,593, against $843,609 in 1917. The Bingham district, with its large output of copper and other ores, produced $2,056,005 in gold in 1918, and the Tintic district, partly in Juab County and partly in Utah County, produced $678,952. The production of placer gold in 1918 was only $1,368, and the output recovered by cyanidation and amalgamation was about $4,200. The greater part of the Utah gold (53 per cent) was derived from copper ores mainly mined in Salt Lake and Juab counties; lead and lead-zinc ores contained 31 per cent.

Silver.—The total output of silver in Utah from 1864 to 1918, inclusive, has been 379,476,124 fine ounces, according to Heikes.[2]

The mine production of silver in Utah in 1918 was 13,455,597 ounces, a decrease of 23,536 ounces. The largest production was from Juab County, credited with 4,994,806 ounces (mainly from lead ores), against 4,988,005 ounces in 1917. Salt Lake County had the next largest output, 3,022,638 ounces (from copper, lead, and lead-zinc ores), against 3,769,884 ounces in 1917. Of the Salt Lake

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[1] U. S. Geol. Survey Mineral Resources, 1918, pt. 1, p. 327.

[2] Idem, p. 369.

County output of silver, the Bingham district produced about 80 per cent. The Tintic district, in Juab and Utah counties, yielded 6,681,644 ounces (mainly from lead ores); and the Park City region, in Summit and Wasatch counties, produced 2,572,586 ounces, mainly from lead and lead-zinc ores. Altogether the lead ores of Utah yielded 6,672,725 ounces of silver in 1918, the copper ores 1,445,559 ounces, the lead-zinc ores 1,243,638 ounces, and the dry or siliceous ores 3,987,068 ounces. The crude ore smelted in 1918 contained 10,612,588 ounces and concentrates contained 2,316,766 ounces.

WASHINGTON.

The total production of gold in Washington from earliest mining to the end of 1918 is given by C. N. Gerry, of the United States Geological Survey, as $27,753,350, and the total production of silver as 7,363,533 fine ounces.[1]

Gold.—The mine production of gold in Washington in 1918 was $304,658, against $492,324 in 1917. Of the production in 1918 more than 92 per cent was derived from ores shipped directly to smelters, less than 4 per cent came from ores treated by amalgamation or cyanidation, and less than 1 per cent came from placers. Siliceous ores supplied about 96 per cent of all gold recovered and copper ores about 3 per cent. Ferry County alone produced $276,066 in 1918, against $332,071 in 1917. Nearly all the yield from Ferry County was, as usual, from the Republic district.

Silver.—The mine production of silver in Washington increased from 282,320 ounces in 1917, to 310,093 ounces in 1918, of which Ferry County produced 101,376 ounces, mainly from siliceous ores, and Stevens County 168,669 ounces, mainly from copper ores.

WYOMING.

The total production of gold in Wyoming from 1867 to the end of 1918 is given by Charles W. Henderson as $1,235,975, and the output of silver for the same period as 69,540 ounces.[2]

The mine production of gold in Wyoming in 1918 was $871, against $3,762 in 1917, and that of silver 965 ounces in 1918, against 3,415 ounces in 1917. The Hartville district, in Platte County, produced most of the gold mainly from copper ores shipped to smelters. Copper ores shipped from mines in Albany, Fremont, and Carbon counties contained nearly all the remainder of the gold and silver reported in 1918.

PHILIPPINE ISLANDS.

The output of gold in the Philippine Islands from 1907 to 1918, inclusive, has been $9,049,522. The mine production of gold for 1918 was $1,290,000, against $1,408,161 in 1917, $1,514,200 in 1916, $1,320,900 in 1915, $1,371,514 in 1914, $868,362 in 1913, and $570,212 in 1912. The mine production of silver in the Philippine Islands in 1918 was 4,138 ounces and was recovered entirely from gold bullion refined.

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[1] U. S. Geol. Survey Mineral Resources, 1918, pt. 1, p. 497, 1919.

[2] Idem, p. 189.

In 1918 the Benguet Consolidated Mining Co., in the Province of Luzon, treated 23,539 tons of ore which yielded 30,013 ounces of bullion valued at $13.73 an ounce. Other deep mines were operated in 1918 and a considerable quantity of gold was recovered by dredging.

NUMBER OF PRODUCING MINES.

The following table indicates the number of mines producing gold and silver in 1918 divided into placers and deep or lode mines. The placers are those in which the gold and the silver in natural alloy with the gold, and, in a few placers, found also with platinum are recovered from gravels and sands, whether by hand washing, sluicing, hydraulicking, drifting (in frozen ground or ancient buried river channels), or by dredging. The deep mines are those producing gold and silver (from ores as distinguished from gravels) mainly from underground workings, including those whose ores are valuable chiefly for copper, lead, or zinc, but which contribute precious metals as by-products. In addition to producing mines here enumerated, many properties were being prospected and developed (though prospecting and development were less active than usual) without making any output in 1918, and many other mining claims were being held by assessment work only.

The enumeration of placer mines is less satisfactory than that of deep mines, because some of the operations are only temporary and individually small and because the production is frequently by transitory miners not regularly working placer ground. The unit so far as possible is, however, as for deep mines, not the operator, but the mining claim or group of claims.

Number of mines producing gold and silver in 1918.[a]

State or Territory.	Number of mines.		
	Placer.	Deep.	Total.
Alabama	2	1	3
Alaska	727	42	769
Arizona	13	456	469
California	315	388	703
Colorado	12	576	588
Georgia	7	2	9
Idaho	85	216	301
Illinois [b]		2	2
Maryland and Pennsylvania		2	2
Michigan [b]		7	7
Missouri		4	4
Montana	86	407	493
Nevada	54	660	714
New Mexico	9	119	128
North Carolina	8		8
Oregon	78	42	120
South Dakota	6	16	22
Tennessee [c]		2	2
Texas		5	5
Utah	2	248	250
Vermont, Maine, and New Hampshire		5	5
Virginia [c]		1	1
Washington	10	74	84
Wyoming		12	12
	1,414	3,287	4,701

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[a] Philippine Islands and Porto Rico not included.
[b] Number of mines contributing to production of silver.
[c] Number of mines contributing to production of gold and silver.

Number of mines producing gold and silver, 1906–1918.

Year.	Placer.	Deep.	Total.	Year.	Placer.	Deep.	Total.
1906	2,316	2,114	4,430	1914	1,815	3,158	4,973
1907	2,586	2,604	5,190	1915	1,720	3,597	5,317
1908	2,599	2,864	5,463	1916	1,530	3,765	5,295
1909	2,187	3,183	5,370	1917	1,552	3,811	5,363
1910	2,026	3,299	5,325	1918	1,414	3,287	4,701
1911	2,146	3,553	5,699				
1912	2,044	3,567	5,611	Average	1,978	3,254	5,232
1913	1,774	3,502	5,276				

Comparison of the figures for 1918 shows a net total decrease of 662 producing mines, following decrease in 1912, 1913, 1914, and 1916, and an increase of 344 mines in 1915 and 68 mines in 1917. The total number of properties operated in 1918 was 531 less than the average for the last 13 years. The number of placer properties worked in 1918 showed a decrease of 138, and the total was about 900 less than the number operated in 1906. This is a natural result due to the exhaustion of the rich gravels and to the acquisition of large areas of placer ground by dredge mining companies. The number of deep mines operated decreased from 3,811 in 1917 to 3,287 in 1918, or 33 more than the average for 13 years. High costs of labor and material in 1918 resulted in less deep mines being operated than in any year since 1914.

In total number of operating mines Alaska ranked first with 769, followed in order by Nevada with 714, California with 703, Colorado with 588, Montana with 493, Arizona with 469, and Idaho with 301. In number of placers Alaska led with 727, followed by California with 315, Montana with 86, and Idaho with 85; and in deep mines Nevada led with 660, followed by Colorado with 576, Arizona with 456, Montana with 407, California with 388, Utah with 248, and Idaho with 216.

ORE PRODUCTION, CLASSIFICATION, AND AVERAGE VALUE.

The best index of deep mining is, of course, the quantity, metallic content, and value of ore mined, rather than the number of mines or of operators. In the next following table are given the production of ore by classes of ore and by States and Territories from mines producing gold and silver and the average extraction value of precious metals per ton.

The classification adopted is necessarily arbitrary in part. An ore is generally understood to be worked at a profit for one or more metals. The complex nature of western ores, especially, and the gradations from one well-recognized class to another render essential some fixed measures for the terminology used. The dry or siliceous ores comprise gold and silver ores proper, as well as fluxing ores carrying considerable quantities of iron and manganese oxides and very small quantities of gold and silver, and precious metal bearing ores carrying copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The distinction between gold and silver ores is not here made. The total number of silver mines and the total production of true silver ores are both very small. The copper ores include those containing 2.5 per cent or more of copper, or less than this percentage in the great disseminated copper deposits of the West and in the Lake Superior ores; in general, the lead ores are those containing 4.5 per cent or more of lead and the zinc ores are those containing 25 per cent or more of zinc, both irrespective of their precious-metal content; but ores of lower grades in lead and especially in zinc are treated profitably in many districts, and of course they are then classified as lead or zinc ores, as the case may be. The mixed ores are combinations of those enumerated.

The lead, zinc, and lead-zinc ores in many districts in the Eastern and Central States carry no appreciable quantity of gold or silver, and such ores are excluded from this report.

Ore produced and average extraction value of gold and silver per ton in 1918.[a]

State or Territory.	Dry or siliceous ores.		Copper ores.		Lead ores.	
	Quantity (short tons).	Average value.	Quantity (short tons.)	Average value.	Quantity (short tons).	Average value.
Alabama and Georgia	2,000	$0.77	14,960			
Alaska	2,095,573	1.70	722,047	$1.07	4	$92.25
Arizona	295,548	13.60	18,647,039	.41	79,811	5.49
California	1,538,960	5.53	908,059	1.09	38,746	13.71
Colorado	1,760,222	9.35	18,088	11.44	183,274	7.87
Idaho	46,315	7.87	127,898	2.59	1,420,878	5.70
Maine, New York, and Virginia[b]			25,343	.36	43	3.00
Michigan[b]			2,806,000	.18		
Montana	286,522	9.41	6,412,941	1.75	31,423	25.65
Nevada	1,394,583	10.37	4,994,804	.26	48,169	9.92
New Hampshire and Vermont			49,772	.07		
New Mexico	87,214	9.22	4,516,407	.11	17,945	7.02
Oregon	88,723	8.59	37,956	2.97	2	14.50
South Dakota	1,781,569	3.77	637	.45	357	7.66
Tennessee[c]			529,012	.18		
Texas	50,504	10.28	39	1.83	49	142.00
Utah	227,356	19.61	13,512,274	.22	527,759	13.43
Washington	47,151	9.51	83,583	1.91	8,125	.42
Wyoming			2,870	.64		
Total, 1918	9,702,240	6.58	53,409,729	.50	2,356,585	8.24
Percentage of quantity	14.26		78.49		3.46	
Total, 1917	12,166,026	5.56	49,049,181	.49	2,494,077	6.88
Percentage of quantity	18.11		73.02		3.71	

State or Territory.	Zinc ores.		Copper-lead and copper-lead-zinc ores.		Lead-zinc ores.		Total (short tons).
	Quantity (short tons).	Average value.	Quantity (short tons).	Average value.	Quantity (short tons).	Average value.	
Alabama and Georgia							16,960
Alaska							2,817,624
Arizona	2,129	$2.17	916	$19.97	13,043	$3.15	19,038,486
California	17,349	2.24	297	44.67			2,503,411
Colorado	60,350	1.63	1,760	22.36	291,196	2.30	2,314,890
Idaho	5,506	.57	105	16.25	490,917	1.63	2,091,619
Maine, New York, and Virginia[b]							25,386
Michigan[b]							2,806,000
Montana	1,873	1.70	253	11.72	1,090,955	4.40	7,823,967
Nevada	10,977	1.04	800	39.28	23,246	4.99	6,472,579
New Hampshire and Vermont					75	16.00	49,847
New Mexico	110,213		4,072	9.41	13,933		4,749,784
Oregon							126,681
South Dakota							1,782,563
Tennessee[c]							529,012
Texas							50,592
Utah	1,849	.14	7,495	14.52	428,985	4.03	14,706,718
Washington	52						138,911
Wyoming							2,870
Total, 1918	210,298	.76	15,698	16.19	2,352,350	3.47	68,046,900
Percentage of quantity	.31		.02		3.46		100.00
Total, 1917	641,755	.90	31,675	14.58	2,793,613	2.82	67,176,327
Percentage of quantity	.95		.05		4.16		100.00

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[a] Illinois, Missouri, the Philippine Islands, and Porto Rico not included; quantity of crude ore containing precious metals not known.

[b] Includes only copper ore yielding precious metals.

[c] Lead and zinc ores yielded no precious metals.

The total quantity of ore sold or treated from which gold or silver was produced increased from 67,176,327 short tons in 1917, which was the largest ever recorded, to 68,046,900 short tons in 1918. The total of such ores has increased more than 17,500,000 tons in three years. In 1918 the quantity of copper ores sold or treated increased more than 4,360,000 tons; dry or siliceous ores decreased nearly 2,464,000 tons; zinc ores more than 431,000 tons; copper-lead ores, nearly 16,000 tons; lead-zinc ores, 441,000 tons; lead ores nearly 138,000 tons. Arizona, Utah, Montana, and Nevada, led in quantity of ore, owing to the largely increased output from copper mines, the ore from Arizona and Utah being mainly from low-grade disseminated ores and that from Montana mainly from the Butte vein deposits. Nevada ore was mainly from Ely copper ores, but also from siliceous ores from Goldfield, Tonopah, and other districts. New Mexico, Alaska, California, Colorado, Idaho, and South Dakota were next, with an output mainly of dry or siliceous ores from many districts in Alaska, California, South Dakota, and Colorado, and of copper ores from the low-grade ore bodies in New Mexico.

The large production of lead and lead-zinc ores in Idaho ranked that State before South Dakota, which produced ores that were mainly dry or siliceous in character.

The average extraction values in gold and silver were comparatively high for the siliceous ores of Arizona, Colorado, New Mexico, Nevada, Montana, Oregon, Utah, Idaho, Texas, and Washington, and low for the larger ore bodies of California, South Dakota, and Alaska. Some of the States produced comparatively small quantities of copper ore carrying high extraction values in gold and silver, but the copper ores of the important copper-producing States showed low extraction values. The average recovery in gold and silver from the copper ores of Arizona was $0.41 a ton, that of Tennessee $0.18 a ton, that of Montana $1.75 a ton, that of Nevada $0.26, that of New Mexico $0.11, that of Utah $0.22, that of California $1.09, and that of Michigan $0.18. The lead ores of Utah showed an average recovery in gold and silver of $13.43 a ton, and the lead ores of Idaho only $5.70 a ton. Idaho produced the largest quantity of gold and silver bearing lead ores, and Montana the largest quantity of lead-zinc ores. Utah yielded the next largest quantity of lead ore, and the gold and silver content of such ore was more than that of Montana ore of similar character. About 14.26 per cent of the output of ore considered as producing gold and silver was dry or siliceous ore, against 18.1 per cent in 1917; 78.5 per cent was copper ore, against 73 per cent in 1917; 3.46 per cent was lead ore; 3.46 per cent was lead-zinc ore; 0.31 per cent was zinc ore; and 0.02 per cent was copper-lead ore. The average precious-metal extraction value per ton of siliceous ores of the United States increased from $5.56 to $6.58, that of zinc ores decreased from $0.90 to $0.76, and that of copper-lead ores increased from $14.58 to $16.19. The average gold and silver value of copper ores per ton was 51 cents in 1916, 49 cents in 1917, and 50 cents in 1918, and that of lead-zinc ores increased from $2.82 in 1917 to $3.47 in 1918.

DISTRIBUTION OF MINE PRODUCTION OF GOLD IN 1918, BY SOURCES.

As shown by the following table, the great bulk of the domestic output of gold is obtained from dry or siliceous ore—normally gold quartz and gold-silver quartzose ores—and from placers, more than 87 per cent of the total production of gold coming from these sources alone. The total contribution of gold derived from the great copper, lead, and zinc mines of the country is therefore relatively small, notwithstanding their recent enormous development and production of ore.

It is interesting to note, however, that the placer mines and dry or siliceous ores yielded 1 per cent less of the total gold than they did in 1917. The contribution of gold from dry or siliceous ores, which had gradually declined from about 69 per cent in 1910 to about 66 per cent in 1914 and had increased to nearly 68 per cent in 1915, decreased more than 4 per cent in 1916, was 62 per cent in 1917, and 63.7 per cent in 1918. The yield of gold from copper ores, which had increased from 6 per cent in 1914 to 7 per cent in 1915 and to 9 per cent in 1916, decreased to less than 9 per cent in 1917 and increased to 9.6 per cent in 1918.

Mine production of gold in 1918, in fine ounces.[a]

State or Territory.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead and copper-lead-zinc ores.	Lead-zinc ores.	Total.
Alabama and Georgia	239.94	83.68						323.62
Alaska	285,412.50	168,021.71	5,206.84					458,641.05
Arizona	204.82	149,999.60	108,750.43	3,689.47	3.00	34.83	237.28	262,919.43
California	379,200.93	400,912.60	15,443.97	3,988.75	20.27	21.58		799,588.10
Colorado	25,455.02	566,274.64	1,968.68	17,086.60	1,098.26	198.17	4,882.99	616,884.36
Idaho	13,871.33	14,253.45	3,339.71	2,782.34	.24		251.65	33,998.72
Maine			32.99					32.99
Montana	19,167.72	80,613.50	32,464.51	4,747.38	30.82	82.02	13,137.01	150,192.96
Nevada	10,564.13	257,063.06	49,186.44	2,311.40	29.56	929.14	155.72	320,239.45
New Hampshire and Vermont			4.02					4.02
New Mexico	150.83	20,621.04	11,698.51	459.44	4.00	96.20		33,030.02
North Carolina	78.90							78.90
Oregon	24,102.79	33,156.85	4,199.10					61,458.74
South Dakota	20.85	317,571.87	1.55	3.91				317,598.18
Tennessee			235.39					235.39
Texas			.70	.51				1.21
Utah	66.18	22,815.44	75,960.07	20,225.49	1.98	118.96	23,477.98	142,666.10
Virginia			19.35					19.35
Washington	165.98	14,107.36	463.82	.72				14,737.88
Wyoming			42.14					42.14
Total, 1918 [a]	758,201.87	2,045,494.80	309,018.22	55,246.01	1,188.13	1,430.90	42,092.63	[a]3,212,672.56
Percentage of total	23.60	63.67	9.62	1.72	.04	.04	1.31	100.00
Value	$15,673,424	$42,284,130	$6,387,974	$1,142,036	$24,561	$29,579	$870,132	$66,411,836
Total, 1917 [a]	1,026,062.16	2,416,985.19	341,117.42	68,463.87	6,084.87	4,473.74	37,022.14	[a]3,900,209.39
Percentage of total	26.31	61.97	8.75	1.75	.16	.11	.95	100.00
Value	$21,210,587	$49,963,518	$7,051,523	$1,415,274	$125,786	$92,480	$765,316	$80,624,484

[a] Philippine Islands and Porto Rico not included.

PLACERS.

GENERAL.

The total value of the gold produced from placers was $15,673,424 in 1918, against $21,210,587 in 1917. The placer production in Alaska decreased by 189,146 ounces and that in California by 59,755 ounces. These large decreases were due to the scarcity of labor, high cost of supplies, and a shortage of water. The decrease in placer gold from Colorado was 6,522 ounces; from Montana, 3,426 ounces; from Nevada, 3,590 ounces; from Oregon, 11,084 ounces. The only State showing a considerable increase in gold produced from placers was Idaho, the increase being 6,830 ounces.

The placer production is derived chiefly from dredging, from drift mining (which is of decreasing importance in Alaska in frozen ground at no great depth, but of continued importance in California in ancient buried river channels, often at considerable depth), and from hydraulic and sluicing placers. In California, especially, hydraulic mining was of much importance in the past and had become a special branch of the industry in itself, but restrictive laws relative to the débris and to disturbance of navigable streams have in recent years greatly confined mining activity of this kind. Finally, there is a small annual output of gold from dry placers in the Southwest and also a production of gold and platinum from ocean-beach mining in California and Oregon.

Some interesting notes on beach mining in California and Oregon and on dry placers in California, by Charles G. Yale, and on dry placers in Arizona, Nevada, and New Mexico, by V. C. Heikes, were published in the Survey report on gold and silver for 1912, copies of which can still be had on application to the Director, United States Geological Survey, Washington, D. C.

DREDGING.

The production of gold by dredging in the United States and Alaska from the commercial beginning of the industry in 1896 to the end of 1918 has amounted in value according to best available data to $142,995,832, of which $102,625,912 came from California, $19,034,894 from Alaska, $8,843,938 from Montana, $5,273,840 from Colorado, and $3,931,264 from Idaho. Oregon produced more gold from dredging in 1916, 1917, and 1918 than Montana or Idaho and nearly as much as Colorado, and the total production from dredges in Oregon has been about $2,900,000.

Brief details of dredging operations have been given in Mineral Resources in the mines reports on gold, silver, copper, lead, and zinc of the Western States and also in earlier reports of the Director of the Mint. A brief history of gold dredging in the United States was given in the gold and silver (general) report for the year 1914, and the production of gold obtained by dredging in the United States and Alaska from 1896 to the end of 1914 and the number of dredges operated was given by States for each year. Further information is to be found in reports of geological surveys or mining officials of different States. A comprehensive and very useful report is contained in Bulletin 57 of the California State Mining Bureau, "Gold dredging in California," by W. B. Winston and Charles Janin. Other valuable treatises are "Dredging for gold in California," by D'Arcy

Weatherbe, published by the Mining and Scientific Press, and "The history and development of gold dredging in Montana," by Hennen Jennings, with a chapter on placer mining methods and costs, by Charles Janin, published as Bulletin 121 of the Bureau of Mines. The most recent valuable contribution is "Gold dredging in the United States," by Charles Janin, published as Bulletin 127 of the Bureau of Mines.

The gold recovered in the United States and Alaska by 93 gold dredges in 1918 was $10,342,100, against $12,550,425 by 109 dredges in 1917. The decrease in 1918 was more than $2,200,000 and the total yield from dredges, which had been more than $12,200,000 for five consecutive years, 1913–1917, was the smallest since 1910. About 50 per cent of the decrease was owing to the decreased number of dredges operated in Alaska. Of the output in 1918, California produced $7,431,927 from 48 dredges, Alaska $1,425,000 from 28 dredges, Montana $334,750 from 3 dredges, Colorado $522,921 from 6 dredges, and Idaho $239,762 from 4 dredges. Three dredges operating in Oregon produced $387,740. No dredges were operated in 1918 in Nevada, Wyoming, South Dakota, or the Appalachian States.

Gold produced in the United States by dredges, 1896–1918.

Year.	Dredges.	California.	Alaska.	All other States.[a]	Total.
1896	2	$2,000	....	$42,000	$44,000
1897	6	5,000	....	113,556	118,556
1898	8	18,887	....	168,813	187,700
1899	18	206,302	....	227,876	434,178
1900	27	200,929	....	319,108	520,037
1901	34	471,762	....	268,251	740,013
1902	48	867,665	....	501,857	1,369,522
1903	45	1,475,749	$20,000	420,315	1,916,064
1904	61	2,187,038	25,000	511,679	2,723,717
1905	68	3,276,141	40,000	371,235	3,687,376
1906	76	5,098,359	120,000	503,035	5,721,394
1907	79	5,065,437	250,000	340,265	5,655,702
1908	88	6,536,189	170,901	646,481	7,353,571
1909	96	7,382,950	424,993	975,656	8,783,599
1910	115	7,550,254	800,000	942,786	9,293,040
1911	119	7,666,461	1,500,000	1,159,908	10,326,369
1912	124	7,429,955	2,200,000	1,588,956	11,218,911
1913	116	8,090,294	2,200,000	1,936,642	12,226,936
1914	120	7,783,394	2,350,000	2,379,389	12,512,783
1915	114	7,796,465	2,330,000	2,356,660	12,483,125
1916	113	7,769,227	2,679,000	2,338,487	12,786,714
1917	109	8,313,527	2,500,000	1,736,898	12,550,425
1918	93	7,431,927	1,425,000	1,485,173	10,342,100
	....	102,625,912	19,034,894	21,335,026	142,995,832

[a] Other States that have produced gold by dredges are Colorado, which yielded, 1901–1918, $5,273,840; Idaho, 1897–1918, $3,931,264; Montana, 1896–1918, $8,843,938; and Oregon, New Mexico, Nevada, South Dakota, Wyoming, Alabama, Georgia, and North Carolina, a combined yield, 1902–1918, of $3,285,984.

DRY AND SILICEOUS ORES.

In 1918 dry and siliceous ores, including true gold, gold-silver, and silver ores, and precious-metal ores not classed primarily as copper, lead, zinc, or mixed ores, produced $42,284,130 in gold, against $49,963,518 in gold in 1917 and $57,799,310 in 1916. The largest producers from this class of ore are in order of rank: Colorado, California, South Dakota, Nevada, Alaska, and Arizona.

The siliceous ores are in part free-milling (amalgamating), as in Alaska, California, Arizona, and Oregon; both amalgamating and concentrating, as in many States; simply concentrating ores, as in parts of Colorado and Arizona; all-sliming and cyaniding ores; and finally smelting ores. Tailings both from old dumps and from present millings are largely reworked by concentration and subsequent cyanidation.

The loss in tailings from gold mills is being constantly cut down, and the most serious loss remains in tailings from concentrating plants. The chlorination process is of decreasing relative importance, having been used in only a few plants in California in 1917 and 1918. Smelting is mainly of concentrates and of siliceous and pyritic ores, which are also valuable as fluxes. Exact figures of relative output by methods will appear in detail by States in another table.

As most of the production of gold in the United States is derived from placer gravels and dry or siliceous ores, including true gold, gold-silver, and silver ores, the following table for certain States, prepared by V. C. Heikes, of the United States Geological Survey, is of special interest. The table shows the quantity of each class of ore treated and the average content in gold per ton for the period 1913 to 1918, inclusive, for Arizona, Idaho, Montana, Nevada, Utah, and Washington. None of the States had a large yield of gold from gold-silver ores, and Nevada, with a yield much less in 1917 and 1918, than in 1913, was the only State that produced a large quantity of gold from silver ores. Arizona showed an increase in quantity both of gold ore treated and of gold recovered in 1917 and 1918, and the average content per ton in 1918 was considerably more than in 1913. In Idaho the quantity of gold ore treated in 1918 was only 4,752 tons more than in 1913, but the average recovery decreased from 0.410 ounce per ton in 1913 to 0.332 ounce per ton in 1918. In Montana about 5,100 tons more of gold ore was treated in 1918 than in 1913 and the average yield per ton of ore decreased from 0.369 ounce in 1913 to 0.320 ounce in 1918. In Nevada the quantity of gold ore treated in 1918 was about 232,400 tons less than in 1913 and the average recovery of gold per ton decreased from 0.438 ounce to 0.311 ounce. The yield of gold from gold ores in Utah has been comparatively small in recent years and there was a decreased quantity of gold recovered from such ores in 1918 compared with 1917; the yield was less than $7,500, or 3 per cent of that for the year 1913. The quantity of gold ores treated in Washington in 1918 was about 10,000 tons less than in 1913 and the average recovery per ton declined from 0.570 ounce in 1913 to 0.309 ounce in 1918. Nevada has produced since the working of mines in the Tonopah district the greater part of the gold recovered from silver ore. Since 1913 there has been no decrease in the quantity of silver ore treated, but the gold content is so much smaller than it was in 1913 that the quantity of gold recovered has decreased from 144,962 ounces in 1913 to 86,027 ounces in 1918.

Gold produced in six Western States during 1913–1918—total quantity of ore mined and gold produced, compared with quantity and content of gold ore, gold-silver ore, silver ore, and ounces of placer gold, and with number of producers in each class.

Year.	Total number of producers.	Total quantity of ore mined.	Total gold.[a]	Gold ore.			
				Number of producers.	Quantity.	Gold.	Average content.
Arizona:		*Short tons.*	*Fine ounces.*		*Short tons.*	*Fine ounces.*	
1913	438	7,981,862	194,656.69	116	210,228	120,351.91	0.572
1914	395	8,009,927	202,166.62	121	263,895	136,558.47	.517
1915	517	9,612,559	201,531.46	139	182,251	92,771.19	.509
1916	527	17,033,810	192,801.41	105	164,918	63,562.20	.385
1917	484	15,770,193	245,173.83	86	236,585	128,801.16	.544
1918	469	19,038,486	262,919.43	63	201,411	141,126.20	.700
Idaho:							
1913	384	2,451,592	65,043.04	76	36,729	15,074.89	.410
1914	384	2,235,349	55,743.24	84	37,098	13,407.04	.361
1915	412	2,408,846	57,069.49	102	51,786	21,681.77	.419
1916	418	2,718,045	53,977.30	75	69,443	25,068.38	.361
1917	359	2,758,507	38,932.64	70	67,784	24,721.63	.365
1918	301	2,091,619	33,998.72	53	41,481	13,774.92	.332
Montana:							
1913	558	5,960,118	168,994.77	182	229,520	84,748.32	.369
1914	505	5,128,956	199,203.94	183	315,804	116,964.96	.370
1915	643	6,129,924	242,077.93	225	466,818	150,169.29	.322
1916	513	7,860,425	220,130.15	150	498,082	131,175.61	.263
1917	617	6,307,164	170,147.11	137	411,118	103,835.48	.252
1918	493	7,823,967	150,192.96	90	234,663	74,996.31	.320
Nevada:							
1913	786	5,367,211	570,589.41	323	772,749	338,770.66	.438
1914	731	4,522,022	555,402.47	310	837,699	334,137.48	.399
1915	799	5,118,620	551,683.01	203	959,304	333,907.39	.348
1916	779	5,941,165	428,904.21	308	817,100	232,699.56	.285
1917	943	6,473,519	336,664.26	237	589,228	171,815.15	.292
1918	714	6,472,579	320,239.45	195	540,320	167,878.58	.311
Utah:							
1913	217	10,202,566	172,467.95	5	68,408	11,974.24	.175
1914	211	8,544,014	157,961.16	5	1,987	856.32	.430
1915	234	10,451,445	174,590.65	7	13,883	3,226.24	.232
1916	318	13,920,643	172,938.06	10	1,308	663.82	.508
1917	334	15,358,481	162,305.67	6	14,728	4,678.60	.318
1918	250	14,705,718	142,666.10	10	222	359.70	1.620
Washington:							
1913	57	15,685	33,682.30	26	56,008	31,943.98	.570
1914	67	95,947	26,953.24	22	73,618	26.184.86	.356
1915	104	86.677	18,934.90	46	41,412	18,223.36	.440
1916	113	164.998	27.944.06	38	70,048	26,932.84	.384
1917	136	172,119	23,816.17	23	65,058	23,166.31	.350
1918	84	138,911	14,737.83	23	45,434	14,070.56	.309

Gold produced in six Western States during 1913–1918—total quantity of ore mined and gold produced, compared with quantity and content of gold ore, gold-silver ore, silver ore, and ounces of placer gold, and with numbers of producers in each class—Continued.

Year.	Gold-silver ore.		Silver ore.		Placers.	
	Quantity.	Gold.	Quantity.	Gold.	Number of producers.	Gold.
Arizona:	*Short tons.*	*Fine ounces.*	*Short tons.*	*Fine ounces.*		*Fine ounces.*
1913	1,261	406.82	32,216	1,858.40	36	1,484.67
1914	58	46.78	128,759	8,230.65	57	1,458.02
1915	14,349	2,338.97	144,198	9,189.84	49	1,705.12
1916	1,470	994.00	169,916	8,858.47	23	690.84
1917	1	3.62	80,817	3,192.79	32	832.73
1918	2,415	452.21	91,722	8,421.19	13	204.82
Idaho:						
1913	23,390	7,238.56	206	27.82	235	33,574.81
1914	44	92.42	1,100	176.56	208	33,884.46
1915	119	90.81	397	162.87	186	28,294.05
1916	447	227.19	1,793	201.15	162	21,724.87
1917	....	....	1,866	207.64	112	6,541.80
1918	....	....	4,834	478.53	85	13,371.33
Montana:						
1913	13,586	3,763.07	41,382	4,237.81	152	38,748.47
1914	427	451.46	25,854	4,182.65	147	45,579.75
1915	1,025	125.64	25,657	4,760.58	161	45,219.87
1916	999	176.45	24,761	4,075.20	120	34,982.82
1917	7	2.20	33,097	3,335.15	99	22,594.17
1918	233	121.33	51,626	5,495.86	86	19,167.72
Nevada:						
1913	72,909	27,115.32	697,775	144,961.52	64	14,775.75
1914	6,878	3,929.80	676,573	146,181.17	111	18,250.05
1915	16,558	5,372.05	721,753	127,079.12	103	19,123.55
1916	13,330	2,681.38	721,211	116,039.39	65	17,139.89
1917	17,614	3,099.45	807,087	93,757.16	91	14,153.75
1918	14,384	3,157.77	839,879	82,026.71	54	10,564.13
Utah:						
1913	82,165	16,425.10	73,294	4,172.90	7	92.88
1914	77,653	11,901.80	69,379	5,508.11	7	59.55
1915	11,135	1,534.16	36,958	4,488.27	6	46.34
1916	4,337	1,130.41	83,718	7,328.18	8	60.47
1917	25,318	4,864.68	124,011	10,851.33	8	5.42
1918	5	101.75	227,129	22,353.99	8	66.18
Washington:						
1913	4	58.00	120	23.00	12	200.00
1914	....	....	274	269.00	17	278.45
1915	....	....	748	54.36	31	346.00
1916	....	....	428	46.19	23	400.40
1917	48	30.89	533	43.41	17	283.86
1918	....	....	1,717	36.80	10	165.93

[a] Includes placer production given in last column.

Nearly all the siliceous ore in three of the largest gold-producing States—Alaska, California, and South Dakota—yields only small values in silver and is classed as gold ore. The siliceous ores from Colorado include some silver and gold-silver ores, but the great bulk of the siliceous ore is purely gold ore. The quantity of siliceous ore treated each year in these States and the average recovery in gold per ton is as follows:

Siliceous ore treated and gold recovered per ton of ore treated in 1913–1918.

Year.	Alaska.		California.		South Dakota.		Colorado.	
	Ore treated.	Recovery per ton.	Ore treated.	Recovery per ton.	Ore treated.	Recovery per ton.	Ore treated.	Recovery per ton.
	Short tons.	*Ounces.*	*Short tons.*	*Ounces.*	*Short tons.*	*Ounces.*	*Short tons.*	*Ounces.*
1913	1,614,506	0.144	2,031,429	0.267	1,899,139	0.187	2,161,458	0.378
1914	1,738,127	.135	2,050,797	.264	2,019,255	.175	2,157,762	.414
1915	3,020,607	.097	2,368,352	.272	1,889,970	.189	2,183,431	.464
1916	3,548,798	.081	2,192,078	.262	1,870,721	.193	2,057,452	.412
1917	3,414,664	.065	2,018,003	.246	1,867,859	.191	1,996,590	.347
1918	2,095,577	.080	1,538,960	.261	1,781,569	.178	1,760,222	.322

There was a decrease of nearly 1,800,000 tons in the quantity of siliceous ores treated in Alaska and California in 1918, compared with 1917, though the gold content of the ore treated in 1918 was slightly greater. The quantity of siliceous ore milled in South Dakota decreased 86,000 tons and the recovery of gold was less.

COPPER ORES.

The gold obtained as a by-product of the smelting of copper ores sold or treated in 1918 was $6,387,974, against $7,051,523 in 1917, an increase from 8.75 per cent of the total gold yield in 1917 to 9.62 per cent in 1918. The largest production was in Arizona, followed by Utah, Nevada, Montana, California, in the order given. The largest decrease was in California, Alaska, Utah, and New Mexico, caused by a smaller output of copper in those States. As was expected, the increase in the production of copper in Montana and Arizona in 1918 resulted in a recovery of gold from copper ores nearly equal to the output from that source in 1916 from those States. The yield of gold from copper ores in 1919 will be appreciably less than in 1918.

LEAD ORES.

The production of gold in lead ores sold or treated in 1918, chiefly from Utah and Colorado, was $1,142,036, against $1,415,274 in 1917, and $1,486,754 in 1916, or 1.72 per cent of the total domestic output of gold in 1918.

LEAD-ZINC, ZINC, AND OTHER ORES.

The production of gold from lead-zinc ores was $870,132 against $765,316 in 1917, and $589,950 in 1916; from zinc ores $24,561 in 1918, against $125,786 in 1917; and from copper-lead and copper-lead-zinc ores $29,579 in 1918, against $92,480 in 1917. Utah, Montana, and Colorado produced nearly all the gold from lead-zinc ores and Colorado nearly all that from zinc ores. Nevada contributed nearly all the gold from copper-lead ore.

DISTRIBUTION OF MINE PRODUCTION OF SILVER IN 1918, BY SOURCES.

The mine production of silver from the three most important sources of silver—dry or siliceous ores, copper ores, and lead ores—was 88.6 per cent of the total output in 1918, against 86.2 per cent in 1917. The output from dry and siliceous ores increased 1.27 per cent in 1918, following a decrease of 4.35 per cent in 1916 and 0.77 per cent in 1917; that from lead ores decreased 0.1 per cent; that from lead-zinc ores decreased about 1.5 per cent; and that from copper ores increased 1.32 per cent. The combined output from placers, zinc ores, copper-lead ores, and copper-lead-zinc ores was 0.66 per cent of the total production of silver.

Mine production of silver in 1918, in fine ounces.[a]

State or Territory.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead and copper-lead-zinc ores.	Lead-zinc ores.	Total.
Alabama and Georgia	12	15						27
Alaska	38,334	89,695	719,391	369				847,789
Arizona	33	917,973	5,347,618	362,182	4,560	17,578	36,208	6,686,152
California	29,909	228,332	669,711	448,547	38,392	12,820		1,427,711
Colorado	6,650	4,753,627	166,296	1,456,023	75,568	35,260	570,130	7,063,554
Idaho	3,283	69,936	262,991	8,036,861	3,114	1,706	794,449	9,172,340
Illinois[b]				8,171				8,171
Maine, New Hampshire, New York, and Vermont			9,778	129			1,200	11,107
Michigan			509,467					509,467
Missouri			7,892	39,047				46,939
Montana	3,166	1,028,443	10,521,219	707,757	2,556	2,304	4,532,034	16,797,479
Nevada	3,907	9,152,376	278,615	429,917	10,845	12,218	112,721	10,000,599
New Mexico	21	377,855	251,329	116,473	426	36,317		782,421
North Carolina	17							17
Oregon	4,102	77,031	26,161	29				107,323
South Dakota		156,294	256	2,652				159,202
Tennessee			93,620					93,620
Texas		569,565	57	6,943				576,565
Utah	15	3,987,068	1,445,559	6,672,725	215	106,377	1,243,638	13,455,597
Virginia			1,814					1,814
Washington	45	156,772	149,858	3,418				310,093
Wyoming			965					965
Total, 1918[a]	89,494	21,564,982	20,462,597	18,291,243	135,676	224,580	7,290,380	[a]68,058,952
Percentage of total	0.13	31.68	30.07	26.89	0.20	0.33	10.70	100.00
Value	$89,494	$21,564,982	$20,462,597	$18,291,243	$135,676	$224,580	$7,290,380	$68,058,952
Total, 1917[a]	118,604	21,489,465	20,314,233	19,096,474	549,656	448,042	8,645,038	[a]70,661,512
Percentage of total	0.17	30.41	28.75	27.02	0.78	0.64	12.23	100.00
Value	$97,730	$17,707,319	$16,738,928	$15,735,495	$452,916	$369,187	$7,123,511	$58,225,086

[a] Philippine Islands not included.

[b] Fluorspar-lead ores.

PLACERS.

The output of silver from the refining of placer gold was 89,494 fine ounces in 1918, against 118,604 fine ounces in 1917, and 126,351 ounces in 1916. Of the total production 76 per cent came from Alaska and California.

DRY AND SILICEOUS ORES.

The mine production of silver from dry and siliceous ores in 1918 was 21,564,982 fine ounces, against 21,489,465 fine ounces in 1917, and 24,593,656 ounces in 1916. About 42 per cent of this was from Nevada (chiefly from the Tonopah district) and 22 per cent was from Colorado (mainly from the Leadville, Upper San Miguel, and Sneffels districts). The quantity of silver from siliceous ores mined in Utah increased from 2,340,537 ounces in 1917 to 3,987,068 ounces in 1918. There were decreases in many of the States, especially in Nevada, where the production in 1918 was 1,024,341 ounces less than in 1917, and 3,599,535 ounces less than in 1916. Arizona and Montana each produced more than 900,000 ounces of silver from this source, and New Mexico nearly 380,000 ounces. Nearly 99 per cent of the 576,565 ounces of silver produced in Texas was from siliceous silver ores.

A large part of the silver from gold-silver siliceous ores is obtained with the gold by amalgamation and cyanidation in the mills, and the silver is recovered by refining the mill bullion. The remainder is produced by smelting the richer ores and refining the copper or lead bullion produced. A small quantity of silver was also recovered from the leaching of copper ores.

COPPER ORES.

The mine production of silver from domestic copper ores in 1918 was 20,462,597 fine ounces, against 20,314,233 fine ounces in 1917, and 24,541,234 ounces in 1916. The decrease in production of silver from copper ores mined in Alaska was 320,794 ounces; Utah, 779,560 ounces; Nevada, 49,136 ounces; Michigan, 179,084 ounces; and California, 212,769 ounces. Only two of the larger copper-producing States had any increase in silver recovered from copper ores; Montana had an increase of 1,609,830 ounces and Arizona of 133,207 ounces.

The production of silver from copper ores is from the electrolytic refining of Lake and blister copper produced by smelting. The copper ores are mainly sulphides (except the Lake ores of Michigan, which are native metal in amygdaloid and conglomerate matrix), and a greater tonnage contains chalcocite than chalcopyrite or cupriferous pyrite. The great disseminated copper deposits of Utah, Arizona, and New Mexico are of increasing importance, and the lode deposits of Butte, Mont., have long been famous. The silver tenor of the extensive disseminated deposits of the Santa Rita district, N. Mex., and of Ely, Nev., are notably low, but similar deposits elsewhere add considerable quantities of silver.

In Michigan 2,806,000 tons of copper ore yielded 509,467 ounces of silver, or slightly less than 0.2 ounce per ton.

In output of silver from copper ores Montana continued to lead with 10,521,219 ounces in 1918, against 8,911,389 ounces in 1917 and 11,226,034 ounces in 1916; Arizona followed with 5,347,618 ounces in 1918, against 5,214,411 ounces in 1917; Utah ranked third with 1,445,559 ounces in 1918, against 2,225,119 ounces in 1917; and California produced 669,711 ounces in 1918, against 882,480 ounces in 1917. The production of Montana is mainly from Butte, that of Arizona has been chiefly from Bisbee and Jerome, that of Utah from Tintic and Bingham, and that of California from Shasta and Calaveras counties. Of these districts Bisbee well represents the disseminated type; Bingham produces from both lode and disseminated deposits; and the remainder produce silver chiefly from copper ore mined from deep lodes.

LEAD ORES.

The mine production of silver from argentiferous lead ores in 1918 was 18,291,243 fine ounces, against 19,096,474 fine ounces in 1917 and 19,216,586 ounces in 1916. The output from Idaho decreased from 8,063,768 ounces in 1917 to 8,036,861 ounces in 1917, that of Utah decreased from 7,490,650 ounces to 6,672,725 ounces, and that of Colorado increased 288,856 ounces. The yield in Idaho is mainly from the silver-lead ores of the Coeur d'Alene, that in Utah is chiefly from the Park City and Tintic districts, and that in Colorado from Aspen and Leadville. There was a decrease in the production of silver from lead ores in California from 726,174 ounces in 1917 to 448,547 ounces in 1918. There were also decreases in both Nevada and Arizona, but these decreases were more than balanced by an increase of about 320,000 ounces in Montana. Most of the output is from the desilverization of lead bullion from smelting of western ores and concentrates.

ZINC, LEAD-ZINC, AND MIXED ORES.

Argentiferous zinc ores produced 135,676 ounces of silver in 1918, against 549,656 ounces in 1917, mainly as refinery by-products from the smelting of zinc concentrates from Colorado, California, and Nevada.

Lead-zinc ores produced 7,290,380 fine ounces of silver in 1918, against 8,645,038 ounces in 1917, chiefly from concentrates from the Coeur d'Alene in Idaho, the Butte district in Montana, and the Park City region in Utah. The output from Idaho decreased from 3,619,535 ounces in 1917 to 794,449 ounces in 1918. The production of silver from lead-zinc ores in Montana increased from 2,386,824 ounces in 1917 to 4,532,034 ounces in 1918.

Copper-lead and copper-lead-zinc ores produced 224,580 ounces of silver in 1918, against 448,042 ounces in 1917. The output was mainly from Utah, New Mexico, Colorado, Arizona, and California.

SILVER PRODUCTION, BY SOURCES, 1905-1918.

Production of silver in the United States, by sources, as reported by mines, 1905–1918, in fine ounces.[a]

Year.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead and copper-lead-zinc ores.	Lead-zinc ores.	Total.
1905........	112,826	17,187,889	15,762,947	16,070,203	939,252	5,416,723	782,656	56,272,496
1906........	171,068	16,792,799	15,880,870	15,328,653	98,423	6,815,678	2,274,972	57,362,453
1907........	126,808	19,038,042	13,955,436	17,318,811	93,419	489,825	1,474,725	52,497,066
1908........	159,285	19,862,088	14,945,189	14,049,481	37,605	1,099,283	722,906	50,875,787
1909........	152,040	19,826,890	18,300,705	17,027,737	313,948	549,923	1,141,434	57,312,677
1910........	159,381	23,125,042	16,024,543	15,028,076	755,369	535,987	1,968,311	57,596,709
1911........	170,084	25,205,749	16,759,638	15,596,638	630,573	285,006	2,460,152	61,107,840
1912........	163,955	26,363,436	18,744,661	16,632,377	664,421	654,596	2,810,939	66,034,385
1913........	123,739	28,010,875	18,250,253	18,629,246	86,432	752,563	5,334,120	71,187,228
1914........	152,128	27,812,335	14,829,828	19,302,081	145,264	248,866	7,132,747	69,623,249
1915........	154,968	25,709,505	18,781,365	19,828,533	1,136,220	234,047	6,509,092	72,353,730
1916........	126,351	24,593,656	24,541,234	19,216,586	1,274,292	533,273	8,572,141	78,857,533
1917........	118,604	21,489,465	20,314,233	19,096,474	549,656	448,042	8,645,038	70,661,512
1918........	89,494	21,564,982	20,462,597	18,291,243	135,676	224,580	7,290,380	68,058,952
	1,980,721	316,582,703	247,553,499	241,416,139	6,860,550	18,288,392	57,119,613	889,801,617

[a] Philippine Islands excluded.

This table shows that the production of silver as reported by the mines had increased from 50,875,787 fine ounces in 1908 to 70,661,512 ounces in 1917, and that the production in 1918 was about 2,600,000 ounces less than it was in 1917. The production from siliceous and copper ores was slightly more than in 1917, but that derived from lead, zinc, and lead-zinc ores shows a decrease. The recoveries from dry or siliceous ores reached its apex in 1913, when the yield from Tonopah mines was at its zenith, and the production in 1918 was about 6,446,000 ounces less than it was in 1913. The yield of silver from copper ores has increased from 13,955,436 ounces in 1907 to 20,462,597 ounces in 1918, or about 47 per cent. The total yield of silver from zinc ores has been comparatively small, though the output from that kind of ore which had increased from 37,605 ounces in 1908 to nearly 550,000 ounces in 1917 decreased to 135,676 ounces in 1918. The combined production of silver from lead and lead-zinc ore increased from 14,772,387 ounces in 1908 to 25,581,623 ounces in 1918.

The production of silver from siliceous ores will probably increase slightly in 1919 and that from copper ores and lead ores may decrease considerably, owing to the smelter output of those ores in 1919. It is not expected that the production of silver in the United States in 1919 will show any increase, for the loss from copper and lead ores will exceed the gain in the recoveries from siliceous ores.

DISTRIBUTION OF PRODUCTION OF GOLD AND SILVER BY METHODS OF TREATMENT.

SUMMARY OF DISTRIBUTION.

In the following table is given a summary of the distribution of the production of gold and silver in the United States in 1918, showing (1) total crude ore, tailings, and slags sold or treated; (2) crude ore treated in gold and silver mills; (3) crude ore concentrated and resulting concentrates; (4) crude ore shipped to smelters; (5) old tailings and slags treated. The last four items include recoverable gold and silver content in fine ounces.

Distribution of gold and silver produced in 1918, by States.[a]

State or Territory.	Total quantity of crude ore, tailings, and slag treated or sold in 1918.	Ore to gold and silver mills.			Crude ore.			
		Quantity.	Gold in bullion.	Silver in bullion.	To concentrating mills, quantity.	Concentrates produced from all sources.		
						Quantity.	Gold.	Silver.
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Short tons.*	*Short tons.*	*Fine ounces.*	*Fine ounces.*
Alaska	2,817,624	1,904,176	117,229	26,165	807,445	85,778	50,193	506,573
Arizona	19,038,486	203,654	141,039	158,476	13,125,101	865,232	20,298	1,109,510
California	2,503,411	1,414,644	294,996	104,152	585,919	92,191	99,743	281,056
Colorado	2,314,890	1,345,451	455,276	345,280	555,262	226,292	81,395	2,330,637
Idaho	2,091,619	40,845	10,379	9,952	1,734,718	316,886	5,610	6,229,450
Montana	7,823,967	175,066	45,004	115,716	5,961,753	2,050,823	43,270	13,471,445
Nevada	6,472,579	1,042,874	237,576	8,096,148	4,560,562	544,061	46,155	509,928
New Mexico	4,749,784	70,179	17,081	264,070	4,551,983	353,761	11,910	210,026
Oregon	126,681	88,669	32,795	75,388	33,583	6,876	3,974	25,239
South Dakota	1,782,563	1,781,362	317,453	153,781	....	....	....	....
Texas	50,592	50,504	....	569,565	....	....	....	....
Utah	14,705,718	1,012	203	4,525	13,071,152	808,021	75,521	2,316,706
Washington	138,911	1,022	566	224	72,951	4,234	344	105,880
Wyoming	2,870	....	....	....	....	....	....	....
Eastern or Appalachian States[b]	621,205	2,000	84	15	75,115	8,059	37	9,778
	65,240,900	8,121,428	1,669,681	9,923,457	45,135,544	5,357,214	438,450	27,106,268
Total, 1917	63,935,882	10,329,197	1,927,528	11,753,827	42,905,807	5,244,959	488,297	26,219,931

[a] Exclusive of small quantity of silver from copper ores in Michigan and Missouri and from lead ores in Illinois and Missouri, and of gold and silver from the Philippine Islands and Porto Rico.

[b] Copper, zinc, and zinc-lead ores containing no silver excluded.

Distribution of gold and silver produced in 1918, by States—Continued.

State or Territory.	Crude ore to smelters.			Old tailings and slag treated.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Short tons.*	*Fine ozs.*	*Fine ozs.*
Alaska	106,003	5,407	276,717	....	[a] 400	....
Arizona	3,845,332	101,166	5,372,505	1,864,399	212	45,628
California	448,523	21,859	982,619	54,325	3,789	29,975
Colorado	414,177	54,738	4,380,987	....	....	....
Idaho	186,551	4,593	2,912,490	129,505	45	17,165
Montana	478,860	40,070	2,771,937	[b] 1,208,318	[b] 2,681	[b] 435,215
Nevada	623,828	25,440	1,365,603	[c] 245,315	504	25,013
New Mexico	127,622	3,888	308,304	....	....	....
Oregon	4,411	570	2,588	18	17	6
South Dakota	1,201	124	5,421	....	....	....
Texas	88	1	7,000	....	....	....
Utah	967,597	65,139	10,612,588	[d] 665,957	1,737	521,703
Washington	64,938	13,662	203,964	....	....	....
Wyoming	2,870	42	965	....	....	....
Eastern or Appalachian States	544,090	235	94,949	....	19	1,814
	7,816,091	336,934	29,298,637	4,167,837	9,404	1,076,519
Total, 1917	8,645,869	434,743	30,758,752	2,055,009	23,579	1,053,075

[a] Old plates, etc.

[b] Gold and silver from 21,575 tons of old tailings cyanided, included under recoveries at gold and silver mills. Includes 587,702 tons of old tailings and ore leached.

[c] Gold and silver from 232,053 tons of old tailings cyanided, included under recoveries at gold and silver mills.

[d] Includes 282,894 tons of ore leached.

The first item consists of all classes of ores, tailings, and slag from which gold and silver were produced in 1918. The grand total is 65,240,900 short tons in 1918, against 63,935,882 short tons in 1917, and 64,409,377 tons in 1916. This takes no account of placer gravel but represents output of mines producing ore only. The greatest output was from Arizona, Utah, Montana, Nevada, and New Mexico, all notable for large yield of copper ores.

In reference to the second item many gold and silver mills employ concentrating apparatus, and the concentrates obtained are combined in the table with those from straight concentrating mills under the heading "Concentrates produced." The gold and silver recovery under this item is mainly by amalgamation and cyanidation, as is shown in detail in the last table of this report. The total quantity of crude ore treated in gold and silver mills in 1918 was 8,121,428 short tons, against 10,329,197 short tons in 1917, and 11,249,436 tons in 1916. The greatest quantities milled were in Alaska, South Dakota, California, Colorado, and Nevada. The total recovery of gold from the mills was 1,669,681 fine ounces in 1918, against 1,927,528 fine ounces in 1917, and 2,118,252 ounces in 1916, and the production was, as usual, chiefly from Colorado, South Dakota, California, Nevada, Arizona, and Alaska in the order named. The total silver recovery in mills was 9,923,457 fine ounces in 1918, against 11,753,827 fine ounces in 1917, and 14,724,426 ounces in 1916, and came very largely from Nevada (from Tonopah, Wonder, and Rochester districts chiefly) but also in much smaller quantities from Texas, Colorado, New Mexico, and Arizona.

Under the third item is given the quantity of ore treated by concentration only, including the large quantities of copper, lead, zinc, and mixed ores, whose concentrates are smelted primarily for these metals, the gold and silver being recovered in refining the copper and lead bullion and smelting the zinc residues. Examples are the copper ores of the disseminated deposits of Bingham, Utah, and of New Mexico and Nevada; the copper ores of Butte, Mont.; and the lead and lead-zinc ores of Coeur d'Alene, Idaho, Butte, Mont., and Leadville, Colo. The quantity of concentrates produced and the recoverable gold and silver content, however, as already stated, represent not only the concentrates from these straight concentrating mills but also those from gold and silver mills, which form, however, a very small part of the total quantity of concentrates and are mainly derived from Alaska, California, South Dakota, and Colorado ores. These concentrates are mainly smelted but are also treated in gold and silver mills by the processes named.

The ore treated in straight concentration mills increased from 42,905,807 short tons in 1917 to 45,135,544 tons in 1918, mainly because of greater activity at copper mines in Montana and Arizona. Arizona ranked first in quantity of ore concentrated, followed by Utah, Montana, Nevada, New Mexico, and Idaho. These quantities, with the exception of those of Montana and Idaho, represent largely low-grade disseminated copper ores milled. The total quantity of gold and silver bearing concentrates from all classes of milling ore increased from 5,244,959 short tons in 1917 to 5,357,214 tons in 1918. Montana mills produced the largest quantity of concentrates, or 38 per cent, followed by those of Arizona, Utah, Nevada, New Mexico, and Idaho. The total recoverable content of all concentrates was 438,450 ounces in 1918, against 488,297 ounces in 1917, and 547,172 ounces in 1916, and came mainly from California, Colorado, Utah, Alaska, and Nevada, in the order named. The total recoverable silver from concentrates produced was 27,106,268 ounces in 1918, against 26,219,931 fine ounces in 1917 and 29,566,150 ounces in 1916, and nearly one-half the total came from Montana—Idaho, Colorado, Utah, Arizona, and Nevada being the other States in which large quantities of silver were recovered from concentrates. The increase was entirely owing to a larger output in the silver in concentrates derived from ores mined in Montana.

The fourth item covers the quantity and the recoverable precious-metal content of crude ores shipped from the mines direct to the smelters, and in general includes the richer gold, silver, copper, lead, and mixed ores from which the gold and silver is eventually recovered by refining the copper or lead bullion that collects the precious metals in the smelting. The total quantity shipped of this class of ore decreased from 8,894,609 short tons in 1916 and 8,645,869 tons in 1917 to 7,816,091 tons in 1918. The output was notably from Arizona, which produced nearly one-half of the ore directly smelted, followed by Utah, Nevada, Eastern or Appalachian States, Montana, California, and Colorado, in the order named. The total yield of gold from crude ores smelted decreased from 434,743 fine ounces in 1917 to 336,934 ounces in 1918, and came chiefly from Arizona, Utah, Colorado, Montana, Nevada, and California, in the order given. The total recoverable silver output decreased from 30,758,752 fine ounces in 1917 to 29,298,637 ounces in 1918, and was notably from Utah, Arizona, Colorado, Idaho, Montana, Nevada, California, and New Mexico. Utah and Arizona produced more than half of the silver recovered from crude ore smelted.

Under the fifth item is given the quantity of old materials, principally tailings and slags, re-treated, and also the ore and tailings leached, and their recoverable contents. These are partly smelted, often for their fluxing as well as their metal value; but considerable quantities of old tailings are now concentrated and cyanided, and the impounding of mill tailings for future treatment as well as because of legal requirements has now become a general practice. The total quantity of all old material treated as shown in the table increased from 2,055,009 short tons in 1917 to 4,167,837 tons in 1918. The increase in quantity of old material treated in 1917 and 1918 (only 894,030 short tons were treated in 1916) was due mainly to the high prices of copper and lead. Most of the gold and silver derived from old tailings is included under recoveries by amalgamation and cyanidation at gold and silver mills. The total quantity of ore leached in 1918 was 2,127,599 short tons, of which 1,776,000 were from Arizona mines, 282,894 tons were from Utah mines, 68,502 tons from Montana mines, and 203 tons from Nevada mines. The total quantity of old tailings and slag concentrated or directly smelted in 1918 was 2,040,238 tons, most of which was from Montana, Utah, and Nevada.

PERCENTAGE OF OUTPUT OF GOLD AND SILVER PRODUCED BY DIFFERENT PROCESSES.

Percentage of output of gold and silver produced by different processes, 1913–1918.

Process.	Percentage of total output.											
	Gold.						Silver.					
	1913	1914	1915	1916	1917	1918	1913	1914	1915	1916	1917	1918
Placers	24.9	25.2	22.7	25.0	25.8	23.2	0.2	0.2	0.2	0.2	0.2	0.13
Gold and silver mills:												
By amalgamation	21.5	20.9	22.8	21.5	20.9	20.7	.6	.4	.4	.4	.4	.3
By cyanidation	31.2	31.4	30.4	28.1	29.5	32.0	19.7	22.1	22.1	18.3	16.3	14.3
By chlorination	.3	.4	.5	.5	.2	.2	......	......	......	......	......	......
Total milling	53.0	52.7	53.7	50.1	50.6	52.9	20.3	22.5	22.5	18.7	16.7	14.6
Smelting [a]	22.1	22.1	23.6	24.9	23.6	23.9	79.5	77.3	77.3	81.1	83.1	85.3
Total [b]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Both crude ore and concentrates.

[b] Philippine Islands and Porto Rico excluded.

The placers produced about 23.2 per cent of the total output of gold—a decrease of 2.6 per cent. The dredges produced nearly 18 per cent less gold in 1918 than in 1917, and the combined placer yield from hydraulic, drift, and other surface methods was about $5,540,000 less than in 1917. The decrease from placers was largely due to a smaller output from Alaska, California, and Oregon. The percentage of output of silver credited to the placers is insignificant.

In the mills the amalgamation process showed a loss of 0.2 per cent of the total recovery of gold in 1918. This was due to the decrease in mining and milling in Colorado, California, and South Dakota, which produce ores more amenable to treatment by amalgamation. The gold recovered by cyanidation showed an increase of 2.5 per cent, following an increase of 1.4 per cent in 1917. Colorado, Nevada, Arizona, Oregon, and South Dakota ores yielded the larger part of the gold recovered by cyanidation. The chlorination process was only used in a few mills in California and the output of gold therefrom was less than 0.2 per cent of the total recovery of gold. None of the Colorado plants used chlorination in 1917 and 1918, and the total recovery of gold by that process in California mills amounted to $119,173.

GOLD AND SILVER PRODUCED AT MILLS, BY STATES.

A large quantity of concentrates from sulphide ores is now smelted, and the increased application of the flotation process has resulted in decreased yield of gold and silver from cyanidation, as nearly all such concentrates are shipped to smelters.

The smelters, which had for two years been producing each year a slightly greater proportion of gold and silver, are to be credited in 1918 with about 23.9 per cent of the total output of gold and 85.3 per cent of the silver.

The bulk of the production of gold remains mainly from the gold mills. As shown by the table above the proportion of gold recovered by amalgamation, cyanidation, and chlorination has decreased from 53.6 per cent in 1912 to 52.9 per cent in 1918.

The following table shows in greater detail the ore treated and the output of gold and silver mills, by States, in 1918:

Gold and silver produced at mills in 1918, by States. [a]

State.	Ore and tailings treated.	Bullion recovered.				Percentage of gold and silver from all sources.			
		Amalgamation.		Cyanidation.		Amalgamation.		Cyanidation.	
		Gold.	Silver.	Gold.	Silver.	Gold.	Silver.	Gold.	Silver
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*				
Alaska	1,904,176	116,363	26,054	22,127	2,102	25.4	2.6	4.8	0.3
Arizona	222,897	845	451	140,193	158,025	.3		53.3	2.4
California [b]	1,414,644	283,293	71,103	46,290	60,870	35.5	4.9	5.8	4.3
Colorado	[c]1,475,648	25,234	17,554	430,042	327,726	4.1	.2	69.5	4.6
Idaho	40,845	9,719	7,103	660	2,849	28.6	.1	.2	
Montana	196,611	1,255	618	43,749	115,098	.8		29.1	.7
Nevada	1,274,927	22,076	17,459	215,500	8,078,689	6.9	.2	67.3	80.8
New Mexico	70,179	12,117	1,956	4,964	262,114	36.7	.2	15.0	33.5
Oregon	88,669	4,607	18,019	28,205	57,375	7.5	16.8	45.9	53.5
South Dakota	1,781,362	202,219	55,932	115,234	97,849	63.7	35.1	36.2	61.5
Texas	50,504				569,565				98.8
Utah	1,012	62	365	141	4,160			.1	
Washington	1,022	485	41	81	183	3.3		.6	.1
Wyoming									
Appalachian States	2,000	84	15			12.1			
Total, 1918	8,524,496	678,359	216,670	1,047,186	9,736,605	20.7	.3	32.0	14.3
Value		$14,022,925	$216,670	$21,647,256	$9,736,605				
Total, 1917	11,076,211	828,681	288,791	1,169,478	11,535,747	20.9	.4	29.4	16.3
Value		$17,130,357	$237,976	$24,175,256	$9,505,455				

[a] Porto Rico and Philippine Islands excluded.

[b] Recovered by chlorination, 5,769.83 ounces of gold and 3,631 ounces of silver in California. Value of gold recovered by chlorination was $119,173, that of silver, $3,631.

[c] Part of ore amalgamated followed by cyanidation of new tailings. Total ore and new tailings cyanided, 1,161,161 tons.

Figures corresponding to those in this table were collected and compiled for the entire United States by the Geological Survey for the first time in 1911, and comparison for eight years can therefore now be made.

The total quantity of crude ore treated and old tailings re-treated in gold and silver mills was 8,524,496 short tons in 1918, against 11,076,211 tons in 1917, 11,393,838 tons in 1916, 11,878,287 tons in 1915, 9,849,085 tons in 1914, 9,401,856 tons in 1913, 9,677,360 tons in 1912, and 9,670,483 tons in 1911. In 1918 ores from Alaska, South Dakota, Colorado, California, and Nevada treated at gold and silver mills amounted to about 92 per cent of the total quantity.

The great bulk of the ore treated, as shown, was milled in Alaska, South Dakota, Colorado, California, and Nevada, in the order named, and here the famous mills of the Homestake, Mother Lode, Grass Valley, Treadwell, Cripple Creek, Tonopah, and Goldfield mines are especially in evidence. Large numbers of smaller mills, however, mark the wide distribution of gold mining in these regions and in many other scattered districts.

The total yield of gold by amalgamation in the United States in 1918 was 678,359 fine ounces, valued at $14,022,925, against 828,681 fine ounces, valued at $17,130,357, in 1917, and 964,589 ounces, valued at $19,939,824, in 1916. The output in 1918 was 283,293 ounces in California, 202,219 ounces in South Dakota, 116,363 ounces in Alaska, 25,234 ounces in Colorado, and 22,076 ounces in Nevada. There was no appreciable increase shown in any State, though there were large decreases in 1918 in California, South Dakota, Idaho, Oregon, and Washington.

The total yield of silver by amalgamation in 1918 was only 216,670 fine ounces, valued at $216,670, against 288,791 ounces, valued at $237,976, in 1917. The output came mainly from California, South Dakota, Alaska, Oregon, Colorado, and Nevada, in the order given, and consisted chiefly of silver alloyed with gold.

The total output of gold by cyanidation in 1918 was 1,047,186 fine ounces, valued at $21,647,256, against 1,169,478 fine ounces, valued at $24,175,256, in 1917, and 1,260,172 ounces, valued at $26,050,067, in 1916. The output was 430,042 ounces in Colorado, 215,500 ounces in Nevada, 140,193 ounces in Arizona, 115,234 ounces in South Dakota, 46,290 ounces in California, 43,749 ounces in Montana, 28,205 ounces in Oregon, and 22,127 ounces in Alaska, in 1918. The only important increases in 1918 were that of Arizona, amounting to 21,431 ounces, and that of California, 23,640 ounces. The principal decreases were in Alaska, 25,688 ounces: Colorado, 94,405 ounces; Montana, 20,313 ounces; Nevada, 10,817 ounces; South Dakota, 12,326 ounces.

The total yield of silver by cyanidation in 1918 was 9,736,605 fine ounces, valued at $9,736,605, against 11,535,747 fine ounces, valued at $9,505,455 in 1917, and 14,432,378 ounces, valued at $9,496,505, in 1916. Nevada led, with the bulk of the output (8,078,689 ounces), and was followed by Texas with 569,565 ounces, Colorado with 327,726 ounces, and New Mexico with 262,114 ounces. The most notable losses were in Arizona, 94,627 ounces; Nevada, 1,141,663 ounces; New Mexico, 393,067 ounces; Colorado, 52,926 ounces; Montana, 118,724 ounces.

The quantity of gold recovered from ore treated by amalgamation decreased about 150,300 ounces in 1918, and that recovered from ores cyanided decreased about 122,300 ounces.

Of the gold-producing States, whose chief output is from milling ores, Alaska, California, New Mexico, and South Dakota still yield more gold by amalgamation than by cyanidation, whereas the latter process produces more gold than amalgamation in Arizona, Colorado, Montana, Nevada, and Oregon, and it produces much more silver in Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, South Dakota, and Texas. Alaska, California, and Idaho were the only States in which the recovery of silver by amalgamation exceeded that by cyanidation. Altogether amalgamation produced gold and silver valued at $14,239,595 from milling ores in 1918, against $31,383,861 produced by cyanidation from such ores in that year.

Of the total output of gold from all sources in 1918, amalgamation produced 25.4 per cent in Alaska, 35.5 per cent in California, 36.7 per cent in New Mexico, and 63.7 per cent in South Dakota; and cyanidation produced 53.3 per cent in Arizona, 69.5 per cent in Colorado, 29.1 per cent in Montana, 67.3 per cent in Nevada, 15 per cent in New Mexico, and 36.2 per cent in South Dakota.

Of the total output of silver from all sources in 1918, amalgamation produced 35.1 per cent in South Dakota and 16.8 per cent in Oregon, and cyanidation produced 80.8 per cent in Nevada, 33.5 per cent in New Mexico, 53.5 per cent in Oregon, 61.5 per cent in South Dakota, and 98.8 per cent in Texas.

QUICKSILVER AND POTASSIUM AND SODIUM CYANIDE CONSUMED IN CERTAIN STATES.

For details of the consumption of quicksilver in the amalgamation milling process and of potassium cyanide and sodium cyanide in the cyanidation process the reader is referred to the mines reports of the several Western States named in the prefatory note. Data as to consumption of these supplies are not yet furnished by a sufficient number of mining and milling companies to justify tabulation for the entire United States. It has been estimated by H. D. McCaskey that the consumption of quicksilver in the amalgamation process in the United States (including Alaska) for the period 1911 to 1917, inclusive, has varied between 90,000 and 100,000 pounds annually. In 1918 the consumption probably did not exceed 75,000 pounds, as the gold recovered from placers and by amalgamation was very much less than in 1916 and 1917. The consumption at mills treating ore and by dredging and other methods of placer mining are given in the separate chapters on quicksilver in 1917 and 1918, prepared by F. L. Ransome and published elsewhere in Mineral Resources for 1917 and 1918.

In the following tables, compiled by V. C. Heikes, of the United States Geological Survey, some details are given for the consumption of quicksilver and of cyanide in the recovery of gold and silver in six Western States from 1911 to 1918, inclusive:

Quicksilver consumed in certain Western States, 1911–1918.

State and year.	Number of mills using quicksilver.	Ore and tailings treated.	Total quicksilver.[a]	Quicksilver consumed (average per ounce of gold and silver bullion).
Arizona:		*Short tons.*	*Pounds.*	*Pound.*
1911	26	46,833	1,362.00	0.086
1912	40	28,028	1,414.30	.098
1913	18	36,338	2,912.68	.158
1914	22	44,808	1,802.00	.116
1915	32	34,360	547.00	.063
1916	13	17,568	645.00	.040
1917	9	21,100	205.00	.057
1918	7	1,389	17.00	.012
Idaho:				
1911	35	72,210	1,648.00	.057
1912	43	34,609	700.00	.020
1913	40	28,258	254.00	.019
1914	29	25,877	598.00	.042
1915	36	46,423	1,040.00	.027
1916	36	66,304	1,183.00	.039
1917	27	63,884	1,035.00	.032
1918	22	31,263	953.00	.057
Montana:				
1911	24	61,767	898.00	.031
1912	17	48,837	783.59	.047
1913	23	14,508	289.57	.077
1914	18	29,983	408.00	.074
1915	24	28,504	371.00	.061
1916	18	18,959	206.00	.036
1917	13	8,925	167.00	.040
1918	13	6,492	99.00	.053
Nevada:				
1911	56	781,463	4,753.00	.012
1912	49	388,714	6,636.73	.044
1913	39	360,579	5,054.73	.051
1914	42	250,408	6,826.00	.063
1915	47	211,729	4,367.00	.038
1916	36	131,891	2,111.00	.034
1917	32	67,359	839.00	.020
1918	34	54,048	675.00	.017

[a] Partly estimated.

Quicksilver consumed in certain Western States, 1911–1918—Continued.

State and year.	Number of mills using quicksilver.	Ore and tailings treated.	Total quicksilver.[a]	Quicksilver consumed (average per ounce of gold and silver bullion)
		Short tons.	*Pounds.*	*Pound.*
Utah:				
1911	6	5,020	105.00	.058
1912	4	588	27.70	.145
1913	3	1,157	71.81	107
1914	2	533	20.00	.108
1915	3	1,399	30.00	.020
1916	4	703	15.00	.039
1917	2	190	5.00	.030
1918	2	112	2.00	.018
Washington:				
1911	5	11,846	526.00	.197
1912	9	4,609	121.00	.043
1913	9	768	43.82	.038
1914	5	2,146	43.00	.039
1915	3	1,286	28.00	.031
1916	5	11,495	317.00	.027
1917	4	10,976	185.00	.026
1918	1	960	20.00	.038

State.	1911	1912	1913	1914	1915	1916	1917	1918
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Arizona	1,362.00	1,414.30	2,912.68	1,802.00	547.00	645.00	205.00	17.00
Idaho	1,648.00	700.00	254.00	598.00	1,040.00	1,183.00	1,035.00	953.00
Montana	898.00	783.59	289.57	408.00	371.00	206.00	167.00	99.00
Nevada	4,753.00	6,636.73	5,054.73	6,826.00	4,367.00	2,111.00	839.00	675.00
Utah	105.00	27.70	71.81	20.00	30.00	15.00	5.00	2.00
Washington	526.00	121.00	43.82	43.00	28.00	317.00	185.00	20.00
	9,292.00	9,683.32	8,626.61	9,697.00	6,383.00	4,477.00	2,436.00	1,766.00

[a] Partly estimated.

Quicksilver consumed in Colorado in 1918 amounted to 6,050 pounds, in New Mexico to 279 pounds, and in South Dakota to 12,252 pounds.

The Mining and Scientific Press, April 6, 1918, contains an article on "The loss of quicksilver in gold mills," by W. J. Sharwood. Tables are given showing available data on the consumption of mercury in stamp mills on a basis of troy ounces of mercury used per short ton of ore for various mills in the United States, Mexico, Canada, South Africa, Chosen (Korea), Celebes, and Australasia.

Potassium and sodium cyanides consumed in certain Western States, 1913–1918, in pounds.

State.	Potassium cyanide.					
	1913	1914	1915	1916	1917	1918
Arizona			715		580	626
Colorado	659,374	35,800	39,600	22,200	135,680	
Idaho			2,894	3,431	1,268	
Montana			1,003	13,305		
Nevada			13,514	140,328	130	
New Mexico	1,415		29,000			
South Dakota	113,727	89,649	11,477	5,300		
Utah			36	1,200		
Washington			1,200			
	774,516	125,449	99,439	185,764	137,658	625

Potassium and sodium cyanides consumed in certain Western States, 1913–1918, in pounds—Continued.

State.	Sodium cyanide.					
	1913	1914	1915	1916	1917	1918
Arizona			226,427	216,841	157,381	157,204
Colorado	260,589	935,589	1,088,592	1,082,617	746,428	779,741
Idaho			3,725	700	3,728	15,600
Montana			162,377	190,249	158,215	83,542
Nevada			3,050,092	2,179,995	1,925,038	1,765,010
New Mexico	190,190	237,511	216,709	176,525	123,500	79,065
South Dakota	388,961	425,397	458,300	419,210	384,938	370,218
Utah			5,320		37,000	2,700
Washington			3,400	2,380		
	839,740	1,598,497	5,214,942	4,268,517	[a] 3,536,228	[a] 3,253,080

[a] Mines in Texas used 37,000 pounds of sodium cyanide in 1917 and 63,130 pounds in 1918.

Potassium and sodium cyanides consumed in certain Western States, 1911–1918.

State and year.	Number of mills using cyanidation process.	Ore and tailings treated	Total consumption of cyanide.[a]	Cyanide consumed.	
				Average per ton of ore and tailings.	Average per ounce of gold and silver.
		Short tons.	*Pounds.*	*Pounds.*	*Pounds.*
Arizona:					
1911	9	152,815	115,877	0.758	0.919
1912	9	202,285	129,987	.642	.973
1913	11	208,591	189,291	.907	1.138
1914	13	294,827	264,969	.900	.369
1915	17	267,639	227,142	.850	.275
1916	9	276,623	216,841	.780	.300
1917	10	227,648	157,961	.69	.430
1918	10	221,508	157,829	.71	.53
Idaho:					
1911	10	64,510	181,808	2.818	4.300
1912	5	54,477	161,156	2.958	3.360
1913	6	37,303	94,475	2.533	3.400
1914	10	12,094	32,529	1.800	2.530
1915	10	4,676	6,619	1.410	.440
1916	8	3,469	4,631	1.33	.38
1917	4	3,793	4,996	1.30	.45
1918	4	9,582	15,600	1.63	4.45
Montana:					
1911	27	203,912	91,657	.449	.610
1912	21	184,487	93,344	.506	.913
1913	24	170,348	116,422	.683	.958
1914	13	192,235	151,738	.789	.921
1915	18	330,140	163,380	.494	.449
1916	18	381,560	203,554	.53	.60
1917	15	328,685	158,215	.48	.53
1918	14	190,119	83,542	.44	.63
Nevada:					
1911	41	1,083,883	2,352,961	2.170	.313
1912	87	1,179,365	2,618,424	2.220	.252
1913	29	1,326,793	2,798,224	2.109	.228
1914	36	1,240,337	3,217,886	2.365	.258
1915	37	1,479,898	3,063,606	2.070	.239
1916	33	1,367,249	2,320,328	1.70	.20
1917	32	1,203,665	1,925,168	1.60	.20
1918	33	1,220,879	1,765,010	1.45	.21
Utah:					
1911	6	268,691	205,041	.763	1.450
1912	6	170,809	203,721	1.193	2.380
1913	6	81,940	70,238	.857	.956
1914	4	17,113	7,396	.432	.607
1915	3	12,064	5,356	.440	.830
1916	2	720	1,200	1.67	4.48
1917					
1918	1	900	2,700	3.00	.63
Washington:					
1911	3	17,381	9,700	.544	2.605
1912	4	16,703	36,517	2.186	.993
1913	2	20,410	32,090	1.572	.998
1914	2	22,387	48,820	2.180	.999
1915	4	1,746	4,600	2.600	.916
1916	1	1,207	2,880	1.97	3.12
1917					
1918					

[a] Partly estimated.

Potassium and sodium cyanides consumed in certain Western States, 1911–1918—Cont.

State.	1911	1912	1913	1914	1915	1916	1917	1918
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Arizona	115,877	129,987	189,291	264,969	227,142	216,841	157,961	157,829
Idaho	181,808	161,156	94,475	32,529	6,619	4,631	4,996	15,600
Montana	91,657	93,344	116,422	151,738	163,380	203,554	158,215	83,542
Nevada	2,352,961	2,618,424	2,798,224	3,217,886	3,063,606	2,320,328	1,925,168	1,765,010
Utah	205,041	203,721	70,238	7,396	5,356	1,200	....	2,700
Washington	9,700	36,517	82,090	48,820	4,600	2,380	....	....
	2,957,044	3,243,149	3,300,740	3,723,338	3,470,703	2,748,934	2,246,340	2,024,681

It has not been possible to obtain a complete report showing the total consumption of potassium cyanide and sodium cyanide used in the recovery of gold and silver in the United States in 1918. If the quantity used in California, Alaska, and Oregon is added to the 3,316,835 pounds reported to have been used in other Western States, the estimated total consumption was probably about 1,900 tons.

The figures given indicate the elimination of the use of potassium cyanide in the recovery of gold and silver, for only about 700 pounds were used in 1918, and this was probably from old stocks at mines. The growing scarcity of potassium cyanide necessarily increased the use of sodium cyanide. The domestic supply of sodium cyanide was sufficient to supply the domestic consumption. As the quantity of bullion recovered was less in 1918 than in 1917, however, the quantities of quicksilver and of cyanide used were less. The quantity of cyanide used per ton of ore or tailings treated and the quantity of gold and silver recovered per pound of cyanide show considerable variations. These variations are doubtless due in part to greater efficiency in large milling plants in some of the States but are mainly caused by the difference in the character and the varying metal content of the ores treated.

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NICKEL.

By Frank L. Hess.

PRODUCTION.

The only nickel produced in the United States in 1918 was about 440 short tons, saved as a by-product in the electrolytic refining of copper. As heretofore, the country obtained its supply from Canada and, in much smaller quantity, from New Caledonian ores matted in France.

Nickel or nickel salts (nickel sulphate or nickel ammonium sulphate) were produced by the American Smelting & Refining Co., Raritan Copper Works, and Nichols Copper Co. The United States Smelting & Refining Co. separated nickel salts from copper-bearing materials made from Canadian ores and belonging to the International Nickel Co. The salts were all returned to the nickel company and are not included in the estimates of American production. The International Nickel Co., which had heretofore refined all its nickel matte at Bayonne, N. J., started refining in 1918 at its new plant at Port Colborne, Ontario. Here it expects to be able to refine enough nickel to supply the British Empire.

The United States Nickel Co., at New Brunswick, N. J., operated on matte made in France from New Caledonian ore.

Nickel content of nickel salts and metallic nickel produced in the United States as a by-product in the electrolytic refining of copper, 1911–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1911	445	$127,000	1915	822	$538,222
1912	328	93,600	1916	918	671,192
1913	241	79,393	1917	402	331,556
1914	423	313,000	1918	441	401,000

IMPORTS.

Nickel imported for consumption in the United States, 1916–1918, by forms.

Form.	1916		1917		1918	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Nickel, alloys, pig, bars, etc	29,917	$7,869	48	$19	40	$8
Ore and matte (nickel content)	72,611,492	9,889,122	75,510,793	9,612,400	73,193,205	11,517,546
Nickel oxide	7,968	2,349	15,926	4,744	13,902	3,221
Nickel sheets and strips		4,896			8,612	6,881
Nickel, all other manufactures of		20,984		45,248	10,495	108,362
	72,649,377	9,925,220	75,526,767	9,662,411	73,226,254	11,636,018

Nickel imported for consumption in the United States, 1910–1918.

Year.	Nickel, nickel ore and matte, nickel oxide, alloys of nickel with copper, etc.		Value of manufactured articles of nickel and nickel sheets and strips.	Total value.
	Quantity (pounds).	Value.		
1910	32,363,251	$4,213,079	$14,759	$4,227,838
1911	29,829,268	4,022,716	27,314	4,050,030
1912	46,317,078	5,724,431	34,536	5,758,967
1913	47,446,520	6,562,555	38,200	6,600,755
1914	35,098,958	5,000,594	28,224	5,028,818
1915	56,599,381	7,629,686	6,458	7,636,144
1916	72,649,377	9,899,340	25,880	9,925,220
1917	75,526,767	9,617,163	45,248	9,662,411
1918	73,207,147	11,520,775	115,243	11,636,018

Nickel ore and matte imported in 1917 and 1918, by countries.

Country.	1917			1918				
	Nickel ore and matte.			Nickel ore and matte.			Manufactures.	
	Quantity (short tons).	Nickel content (pounds).	Value.	Quantity (short tons).	Nickel content (pounds).	Value.	Quantity (pounds).	Value.
Canada	65,916	73,530,259	$9,138,994	63,835	70,645,034	$10,974,325	9,518	$4,441
Australia	2,463	1,980,534	473,406	2,339	2,027,850	433,878		
Other British Oceania				489	409,023	85,934		
Chile				1	91	44		
French Oceania				112	111,207	23,365		
France							86	411
Switzerland							1,172	12,339
England							9,328	5,517
Japan							4,870	6,671
	68,379	75,510,793	9,612,400	66,776	73,193,205	11,517,546	24,974	29,379

EXPORTS.

Nickel, nickel oxide, and matte [a] *exported from the United States, 1909–1918.*

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1909	12,048,737	$4,101,976	1914	27,595,152	$9,455,528
1910	15,244,937	4,704,088	1915	26,418,550	10,128,514
1911	25,099,586	8,283,777	1916	33,404,011	12,952,493
1912	25,815,016	8,515,332	1917	21,992,820	8,936,620
1913	29,173,088	9,686,794	1918	17,469,500	6,927,041

[a] No nickel matte is known to have been exported in the years 1911 to 1918, inclusive.

Manufactures of nickel were exported to the value of $2,152,692.

CONSUMPTION.

The apparent consumption of nickel in the United States since 1911 is shown in the following table. Stocks on hand, which were very considerable at the end of 1918, are not taken into account.

Nickel consumed in the United States, 1911–1918, in short tons.

Year.	Nickel content of ore, matte, etc., imported.	Nickel produced as metal, or content of salts.	Nickel content of exports.	Apparent consumption.
1911	14,915	445	12,550	2,810
1912	23,159	328	12,908	10,579
1913	23,723	241	14,587	9,877
1914	17,549	423	13,798	4,174
1915	28,300	822	13,209	15,913
1916	36,325	918	16,702	20,541
1917	37,763	402	10,996	27,169
191[illegible]	36,604	441	8,735	28,310

CANADIAN NICKEL INDUSTRY.

The International Nickel Co.'s refinery at Port Colborne is described,[1] as follows:

> On July 1, 1918, the plant of the International Nickel Co. of Canada, was put into operation for the treatment of nickel-copper matte. A large supply of matte has been shipped to this refinery during recent months from Copper Cliff, where it is produced at the smelter of the Canadian Copper Co. The bins have also been well stocked with fuels and salt cake. The first operation—smelting the matte with salt cake—is now being carried out in one of the three furnaces. It will take a few weeks to fill up the plant, and then the production of refined nickel on a large scale will have begun. The plant was designed to produce about fifteen million pounds of nickel per year. There will be produced at the same time about half this amount of copper. There is at present no provision for recovering the precious metals at the Port Colborne plant, and the slimes will be sent to the New Jersey refinery of the International Nickel Co. for treatment.
>
> The site selected for the refinery is at Port Colborne, adjoining that of the Canadian Furnace Co. It is close to the Welland Canal and to a branch line of the Grand Trunk Railway. Port Colborne is on Lake Erie at the entrance to the Welland Canal, and the transportation of fuels by water will, therefore, be possible. * * *
>
> The furnace building is a large one—746 feet by 125 feet. It houses three blast furnaces and three converter stands. These are served by seven travelling cranes—two 5-ton, 30-foot span; three 2-trolley, 20-ton, 85-foot span; one 2-trolley, 35-ton, 85-foot span; and one single-trolley, 50-ton, 85-foot span. The furnace stack is an enormous one—365 feet high.
>
> A similar large stack serves the roasting furnaces. There are 10 of these in the oxide department.
>
> In the refining building are two refining furnaces with waste heat boilers. One 15-ton two-hoist and one 5-ton single-hoist cranes serve the furnaces. There are two stacks 100 feet high.
>
> The power house contains four 400-horsepower boilers with chain grate stokers and two 1,000 kilowatt turbo generators. A very complete Cottrell precipitation plant treats the fumes from the furnaces. * * *
>
> Mr. John More is general manager and Mr. James T. Kemp assistant general manager at the Port Colborne plant. There are at present about 350 men employed.

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[1] Canadian Mining Jour., Aug. 1, 1918, pp. 262-263.

The extent of the International Nickel Co.'s operations is indicated by an abstract of its annual report published in the Engineering and Mining Journal of June 29, 1918, page 1180:

> The report for the fiscal year ended March 31, 1918, of the International Nickel Co. shows net earnings of $10,129,988. The company is the most important producer of nickel in the world, with mines in the Sudbury nickel-copper district of Ontario. During the year $5,555,339 was spent in new construction: At the new copper refinery at Port Colborne, $4,385,276; at the Copper Cliff plant, $1,057,074; and at the Orford works, $112,989. Total earnings were $16,181,501, from which general office expense of $610,024 and an estimated provisional reserve for State and Federal taxes of $3,590,836 left $11,980,641 as net income. Items of depreciation and depletion aggregated $1,850,653, leaving net profits of $10,129,988, as stated above. Dividends of $8,064,984 were paid during the year.
>
> War conditions had their effect on the company's operations, but plants were run at capacity throughout the year except as they were affected by the abnormally severe winter. * * * It is noted that the company's policy of expansion has resulted in preventing a serious shortage in the supply of nickel for war requirements.

It has often been suggested that household utensils might be made from pure nickel, but heretofore little has been done in that direction. An article on the subject by Stanley M. Tracy is abstracted by Metal Industry, February, 1918, page 95, thus:

> During the past few years there has been a great deal of discourse as to the proper metal to be used in the manufacture of cooking utensils, owing to various objections to every metal mentioned. After considerable experimental work pure nickel articles were produced a short time ago, and some of the largest hotels in this country as well as abroad have completely equipped their kitchens with utensils made of this metal on account of its various excellent features.
>
> Pure solid nickel must not be confounded with the much inferior metals usually sold as nickel. This, as a rule, for cooking utensils, is made of iron with a thin coating of nickel, which in a short time wears off, leaving the articles unserviceable and worthless.
>
> Pure nickel does not rust or oxidize and consequently every danger of poisoning, generally caused by verdigris is eliminated. Furthermore, the tedious and expensive tinning required for copper and other utensils, which, by the way, also necessitates the use of a larger number of vessels, is entirely abolished.
>
> A further advantage of pure nickel is that the cooking is done quicker than with enameled or copper pans, nickel being altogether a better heat conductor. In the case of aluminum, while this metal is a better heat conductor than nickel, the nickel utensils are made of a thinner material, which more than overcomes the difference. The fine silverlike appearance of pure nickel does not change in use and the cleaning of these utensils is as easy and simple as possible, hot water or soda being quite sufficient.
>
> The great objection to the use of enameled ware is due to the cracking of the enamel, whereby small particles get into the food products, when they have the same effect on the stomach as ground glass. This also affects the wearing qualities of the articles.
>
> In comparison with aluminum, the melting point of which is about 1,200° F., pure nickel has a melting point of about 2,600° F., and the objection to the metal being softened under use would be overcome. Nickel is also much more resistant to the action of the acids found in food products than aluminum. Aluminum also becomes oxidized when used and a film forms on the outer surface, which gives it a greasy feeling. Pure nickel is entirely free from this objection and can be cleaned very easily.
>
> Utensils can be drawn out of one piece of pure solid nickel sheet, making a seamless article, which insures a higher standard of durability, the metal being as hard and tough as steel and therefore being everlasting.
>
> Driver-Harris Co., Harrison, N. J., are now producing pure nickel sheets from which these products can be manufactured, and have found that there is a large use for nickel, among which are slicing machines, which are used for slicing meats and vegetables, parts of bleaching machinery, lead-in spouts on filling machines for canned goods, butter-cutting machinery, valve disks, water-meter gear trains, inner shields of sterilizers and parts of filters, dairy machinery of all kinds, parts of chemical machinery, soap cups, centrifugals, meat choppers, and parts of ice-cream freezers.

RECENT PUBLICATIONS.

Among the recent publications and patents issued on nickel are the following:

Addicks, Lawrence, Impurities in electrolytic copper refining: Met. and Chem. Eng., vol. 16, pp. 687-692, 1917. Abstract by A. Buttes, Chem. Abstracts, vol. 11, pp. 2997-2998, November 20, 1917.

Apart from the blister copper itself, fuel, fluxes, and acids are to be considered as introducing impurities. Of the important insolubles (gold, silver, selenium, tellurium) in the electrolyte, more than 99 per cent goes into the slimes, the remainder contaminating the cathodes mechanically. The soluble impurities foul the electrolyte, nickel and arsenic being the controlling ones. Four distinct methods have been used for purifying the electrolyte: (1) The early method was to cement the copper on scrap iron and waste all of the solution. (2) The free acid was neutralized with shot copper and the copper and acid recovered as bluestone by recrystallization. (3) A portion of the electrolyte in circuit was diverted to a series of three tanks with insoluble anodes, plating out the copper and arsenic by steps to below 0.1 per cent. The nickel, if low, was returned in the purified solution to the circuit. (4) Complete cyclical purification is in general use to-day. The steps in (2) are followed by boiling down and crystallization of the nickel as sulphate. The article gives valuable details and analyses.

Annable, H. W. C., Extracting nickel from silicate ores: U. S. patent No. 1289072, dated December 31, 1918. Chem. Abstracts, vol. 13, No. 7, p. 705, April 10, 1919.

Garnierite ore is ground and then intimately mixed with iron pyrites and sodium chloride, sodium carbonate, sodium sulphate, potassium carbonate, or potassium sulphate and the mixture is heated to 650°-800° in contact with steam and with exclusion of air to form nickel sulphide. The resulting product, containing ferrous sulphide and nickel sulphide, is heated in air to a temperature sufficiently high to oxidize the sulphides to sulphates and to decompose the iron sulphate without decomposing the nickel sulphate, and the hot oxidized product is discharged into water which is maintained at a temperature below 30° to dissolve the nickel sulphate. In case basic nickel sulphate has been formed, hydrochloric acid is added to the water to effect its solution. After separation of the nickel sulphate solution, the nickel may be recovered from it by precipitation with a carbonate or sulphide, that is, by the addition of calcium carbonate to the solution and passing furnace gases from the roasting furnace directly into the solution. The precipitated salt of nickel is dried and heated in the atmosphere to form nickel oxide. If the mixture of sulphides of iron and nickel is heated and sodium chloride is then added to the product to be oxidized, a much lower yield of solution of nickel is obtained. Sea water may be used as a source of sodium chloride in the process.

Bonnefond, M. F., Les mines de Madagascar en 1918: Soc. ing. civils de France Bull., sér. 8, 71^{e} année, Nos. 7-9, pp. 369-370, 1918.

There is a large deposit of hydrosilicate of nickel at Valozoro, near Ambositra. Extensive explorations of this deposit were made in 1912. They developed a mass of lean ore containing 2 to 4 per cent of nickel. Some samples yielded a content of 10 per cent. There are large waterfalls near by. This work, which was done by an English company, will be resumed after the war.

Another deposit has been discovered 25 kilometers east of Ambatondrazaka. Half a score of adits have been run, amounting in all to 350 to 400 meters, through serpentine rocks, and have cut small veins of rich ore, which yields an average of 5 to 6 per cent of nickel. Some specimens contain as much as 12 per cent. The work of development, which was interrupted by the war, will be resumed.

Both these deposits are near large forests and are not far from rivers that have considerable fall, which would furnish all the power necessary for electrometallurgic or electrochemical treatment. The wood needed for the reduction of the ore and for timbering the adits grows almost on the spot.

Colvocoresses, G. M., "Nicu" steel and its manufacture: Canadian Mining Inst. Trans., vol. 21, pp. 48-79, 1918.

Cooper, H. S., Nickel alloy: U. S. patent No. 1277046, dated August 27, 1918. Chem. Abstracts, vol. 12, No. 20, p. 2077, October 20, 1918.

Alloys which are stated to be superior to "high-speed" steel for cutting tools are formed of nickel 71-78, aluminum 7.5-7.9, silicon 3.4-3.8, zirconium 6.1-6.5, and tungsten 4-12 parts. Cobalt may replace nickel, and other metals, such as molybdenum, chromium, or uranium, may be substituted for tungsten.

Cooper, H. S., Nickel alloy: U. S. patent No. 1278304, dated September 10, 1918. Chem. Abstracts, vol. 12, p. 2312, November 20, 1918.

An alloy suitable for making machine tools is formed of aluminum 2 to 14, nickel 81 to 88, silicon 1 to 10, and zirconium 0.5 to 15 parts.

Dresser, M. A., Some quantitative measurements of the minerals of the nickel-eruptive at Sudbury: Econ. Geology, vol. 12, pp. 563–580, 1917. Abstract by A. B. Peck, Chem. Abstracts, vol. 12, p. 1450, 1918.

Thin sections and polished surfaces were used to determine quantitatively the fracturing in the minerals composing the rock. From these observations it was concluded that the schistosity was developed before the norite had entirely solidified, possibly when the Sudbury syncline was formed, giving rise to a "filter-pressing" action, whereby the more liquid magma and aqueous vapors were squeezed out, attacked the pyroxenes, and formed the hornblende and chlorite as now found. Differentiation upon cooling is considered to be the chief source of the ore body, but the idea of filter-pressing is suggested to account for part of the ore and the acid rock near the base of the norite.

Driver, W. B., Nickel alloy for spark-plug electrodes: U. S. patent No. 1274395, dated August 6, 1918. Chem. Abstracts, vol. 12, p. 1951, October 10, 1918.

An alloy for making spark-plug electrodes is formed of manganese 2 per cent, chromium 3.5 per cent, and nickel or cobalt 94.5 per cent.

Fettke, C. R., and Hubbard, Bela, The limonite deposits of Mayaguez Mesa, Porto Rico: Am. Inst. Min. Eng. Bull., pp. 661–676, 1918. Abstract by E. T. Wherry, Chem. Abstracts, vol. 12, p. 891, May 10, 1918.

The location and geology of the region are briefly described. A mantle of bright red soil occurs upon a serpentine rock; analysis of the latter is given, and recalculated into a mineral composition. The most interesting features are the presence of 1.30 per cent nickel-serpentine and the apparent existence of some alumina in a hydroxide form, calculated for simplicity as gibbsite, aluminum hydroxide, 4.21 per cent. Most of the limonite deposit is loose, porous, and earthy. Partial analyses of eight samples are given, with a complete analysis of one. When this is recast into mineral composition, there seems to be present 25.67 per cent of bauxite, with about 65 per cent of iron oxides. Study of the field relations, of thin sections, and of the analyses leads to the conclusion that the limonite has formed by decomposition of the serpentine rock in place, under the influence of circulating waters; the chemical changes involved are outlined. Similar deposits in other regions are also discussed for comparison, many analyses being quoted.

Gillis, J. H., Recovering nickel from nickel-copper alloys: U. S. patent, No. 1260661, dated March 26, 1918. Abstract, Chem. Abstracts, vol. 12, p. 1443, 1918.

An electric current is passed from a nickel-copper anode to a cathode through an electrolyte containing a nickel salt. The polarity of the electrodes is reversed at such intervals and for such periods as to avoid substantial deposition of copper upon the cathode.

Guess, G. A., Electrodeposition of nickel from a nickel-copper anode: British patent No. 118629, dated August 14, 1918. Chem. Abstracts, vol. 13, p. 95, January 20, 1919.

A nickel-copper anode in a nickel sulphate solution is maintained in contact with a reagent which forms with copper suphate an insoluble copper compound and a noninjurious sulphate. The cathode is screened from the reagent and receives a deposit of nickel. Suitable reagents are limestone, calcium oxide, or similar alkaline earths, which give insoluble sulphates, or nickel carbonate, which forms additional nickel sulphate. The reagent may be kept in suspension, in which case the cathode is in a porous pot. Alternately, pieces of the reagent may be placed in a porous pot around the anode. The electrolyte may be heated to 60°–80°.

Guillaume, Charles and Edward, Substitutes for platinum: Nature, vol. 102, p. 64, 1918. Abstract by Albert R. Merz, Chem. Abstracts, vol. 12, p. 2466, December 10, 1918.

Platinum has been used in France since 1900. Details of its applications are given in Guillaume's "Les applications des aciers au nickel," published in 1904. Alloys of nickel high in chromium were first made in France and their properties are described by L. Dumas: Recherches sur les aciers au nickel à haute teneur, 1902. Nichrome is much used in America for electrical heating of laboratory apparatus.

Hadfield, R. A., Iron alloys: British patent No. 126362, dated January 10, 1917. Chem. Abstracts, vol. 13, p. 2193, September 20, 1919.

Iron-nickel alloys are made by alloying from about 5 to 38 per cent of nickel with cast-iron containing from about 2 to 5 per cent of carbon. An example contains 2.58 per cent of carbon, 0.79 per cent of silicon, 0.04 per cent of sulphur, 0.04 per cent of phosphorus, 0.31 per cent of manganese, and 37.2 per cent of nickel. The nickel used is preferably of high quality, such as Mond nickel. One or more other metals, such as chromium, cobalt, vanadium, tungsten, titanium, aluminum, manganese, or copper, may be present.

Honda, Kótaró, A theory of invar: Tokyo Math. Phys. Soc. Proc., 2d ser., vol. 9, p. 348, 1918. Abstract by F. P. Phelps, Chem. Abstracts, vol. 12, p. 2530, December 10, 1918.

In the present theory, invar (35.4 per cent nickel steel) is considered as an irreversible nickel steel, and its remarkable property of nonexpansibility as the result of the retarded $A_{2:3}$ transformation during cooling. Hence the invar is in an unstable condition and tends to elongate very slowly with a lapse of months or years.

Jones, C. L., Alloy: French patent No. 485674, dated January 29, 1918. Chem. Abstracts, vol. 13, p. 1817, August 20, 1919.

An alloy is specified as of the composition nickel 67.8 per cent, copper 28 per cent, manganese 2.5 per cent, iron 1.5 per cent, and vanadium 0.2 per cent. These constituents are alloyed by heating in a furnace or crucible. The product has the luster of silver and the strength of steel, does not corrode in moist air nor when exposed to the action of other agents which commonly corrode metals, and resists the action of most acids. The alloy takes a high polish, may be molded or rolled into bars or sheets, forged, or worked up into any desired shape. It is very compact and may be made into springs, etc.

Parravano, N., Theoretical and experimental investigations on metallic alloys: Ann. Chim. appl. 9, pp. 1–86, Firenze, Italy, 1918. Abstract by Robert S. Posmontier, Chem. Abstracts, vol. 12, p. 1164, June 10, 1918.

A monograph based on investigations carried out by the author, alone and with others. He takes up the following binary alloys: Tin-arsenic, antimony-arsenic, antimony-selenium, bismuth-selenium, manganese-zinc, manganese-bismuth, antimony-potassium, copper-zinc, antimony-bismuth, antimony-copper, manganese-copper, nickel-manganese, nickel-gold. He discusses the general laws of solidification of ternary alloys and treats of the following: Nickel-manganese-copper, iron-nickel-manganese, copper-gold-silver, nickel-copper-gold, iron-manganese-copper, nickel-gold-silver, nickel-copper-silver, nickel-copper-lead, copper-zinc-lead, silver-lead-tin, copper-antimony-bismuth. Similarly as to quaternary alloys, of which the following are discussed: Lead-tin-cadmium-bismuth, iron-nickel-manganese-copper, nickel-copper-gold-silver. Many diagrams of state are given and interpreted in great detail. A bibliography of papers on which the monograph is based is appended.

Perris, B., Projector arc lamps: Canadian patent No. 184914, dated June 11, 1918. Chem. Abstracts, vol. 12, p. 1951, October 10, 1918.

The negative electrode of the arc lamp has a heavy copper coating which is itself covered with a coating of nickel to prevent the beads of molten metal from collecting on the tip of the electrode and spattering the lens of the condenser when the arc springs therefrom.

Proctor, C. H., Government specifications for copper and nickel plating: Metal Industry, vol. 16, p. 407, 1918.

Rand, F. R., and **Vautin, C. T. J.**, Aluminum alloy: British patent No. 122870, dated January 7, 1918. Chem. Abstracts, vol. 13, p. 1299, June 20, 1919.

An aluminum alloy contains 85 to 97.5 per cent of aluminum, and the remainder is a copper-nickel alloy composed of 75 to 80 per cent of copper and 20 to 25 per cent of nickel. In making the alloy, a small amount of aluminum phosphide or copper phosphide may be added as a cleansing agent.

Roberts, H. M., and **Longyear, R. D.**, Genesis of Sudbury nickel-copper ores as indicated by recent explorations: Canadian Min. Inst. Trans., vol. 21, pp. 80–126, 1918; Am. Inst. Min. Eng. Bull., pp. 555–584, 1918. Abstract by J. W. Bowers, Chem. Abstracts, vol. 12, p. 668, April 10, 1918.

A possible succession of events which produced the Sudbury ores is outlined as follows: A laccolithic mass of molten rock was intruded along a plane of unconformity beneath the Animikie sediments. Through some process of differentiation the nature of which is uncertain, this mass separated and consolidated into two distinct but intergrading types, micropegmatite and norite. The sulphides were carried downward with the norite. As the norite consolidated, the sulphides remained in solution and were concentrated in association with an acid component of the magma. This segregation or "extract" made its way to the base of the norite under the influence of complex chemical and physical forces. At the very last stage in the consolidation of the norite, the sulphides were precipitated from the "extract" along the contact, and at the same time the acid component solidified into granite. The presence of water, sulphur, and possibly other mineralizers in the magma allowed this "extract" to replace the wall rock to some extent. But it was still so intimately related to the magma that it was unable to carry the sulphides any great distance into the footwall, unless also accompanied by the molten norite. It is pointed out that the dominant factor controlling the deposition of the Sudbury ores is magmatic segregation in place. Hot solutions may have been active, but only served to influence the local character and position of tho ores.

Sandell, H. K., Nickel-tungsten composition for electrical contact points: U. S. patent No. 1268495, dated June 4, 1918. Chem. Abstracts, vol. 12, p. 1762, September 10, 1918.

A cast-metal composition for contact points of electrical apparatus is formed of nickel 80, tungsten 20, and graphitic carbon 2.5 to 7 parts.

Soerabaya Handelsblad (Java), Quotation in the Algemeen Handelsblad (Amsterdam), from which a translation was reprinted in Commerce Repts., p. 196, October 15, 1918.

States that in the Malili district on the island of Celebes large deposits of rich nickel ores have been found.

United States Nickel Co., Extracting nickel: British patent No. 122335, dated April 11, 1918. Chem. Abstracts, vol. 13, p. 1299, June 20, 1919.

Copper-nickel matte is roasted until it contains 8 to 12 per cent of sulphur, and is then reduced by gases, coke, or other means. If the matte is sufficiently low in sulphur, the roasting is unnecessary. The reduced product is leached with sulphuric acid or hydrochloric acid or copper sulphate to dissolve the nickel and nickel sulphide without dissolving the copper. Some of the partly roasted matte or some metallic nickel may be added to prevent solution of copper or to insure precipitation of any copper which may have been dissolved. The solution of nickel salt may be treated in any way for the extraction of nickel, for example, by the addition of calcium oxide and the subsequent reduction of the hydroxide. British patents No. 17974, 1894, and No. 15850, 1911. Chem. Abstracts, vol. 7, p. 63.

COBALT.

By Frank L. Hess.

PRODUCTION.

Cobalt was produced in the United States in 1918 principally by the Haynes Stellite Co. at Haynes Camp, on Blackbird Creek, Lemhi County, 32 miles southwest of Salmon, Idaho. The 10-stamp experimental mill was operated only part of the year and crushed 4,000 short tons of ore, from which 55 short tons of concentrates were obtained, of which the following is a typical partial analysis:

Analysis of cobalt concentrates from Lemhi County, Idaho.

Insoluble	16.73
Iron (Fe)	15.32
Sulphur (S)	23.75
Arsenic (As)	14.15
Cobalt (Co)	17.74
Copper (Cu)	.63

The cobalt content of the ore was 19,514 pounds, not quite 10 short tons.[1] The Missouri Cobalt Co., at Fredericktown, Mo., mined cobalt, nickel, copper, and iron sulphides, which were shipped to St. Louis and burned in the manufacture of sulphuric acid. The clinker was returned for the extraction of the cobalt, nickel, and copper.

IMPORTS.

The following table is made up from statistics compiled by the Bureau of Foreign and Domestic Commerce:

Cobalt, and cobalt ore and zaffer, and cobalt oxide imported and entered for immediate consumption in the United States, 1907–1918.

Year.	Cobalt, and cobalt ore and zaffer.		Cobalt, oxide of.		Total.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1907	5,219	$1,821	42,794	$73,028	48,013	$74,849
1908	217,548	13,982	1,550	3,095	219,098	17,077
1909	2,314	631	9,818	11,065	12,132	11,696
1910	8,811	1,546	6,124	4,806	14,935	6,352
1911	579,520	48,104	22,934	11,047	602,454	59,151
1912	759,394	67,948	31,848	15,132	791,242	83,080
1913	164,119	69,581	45,277	26,154	209,396	95,735
1914	106,670	53,945	227,886	220,593	334,556	274,538
1915	53,375	70,283	154,672	148,828	208,047	219,111
1916	136,770	175,236	206,639	192,009	343,409	367,245
1917	223,794	369,950	276,406	275,821	500,200	645,771
1918	504,391	628,099	208,596	291,699	712,987	919,798

All the cobalt and cobalt oxide imported in 1918 is thought to have come from Canada.

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[1] All data concerning the company published by permission of J. C. Patten, secretary-treasurer, the Haynes Stellite Co.

STELLITE.

A large part of the cobalt imported is used in the manufacture of high-speed steel, of which it may constitute as much as 30 per cent. A considerable quantity of cobalt oxide is used in the pottery trade also, but the largest single user is probably the Haynes Stellite Co., of Kokomo, Ind. This company is making stellite (the alloy of cobalt and chromium)[1] for lathe tools in greatly increased quantities, and it has added the manufacture of surgeon's and dentist's knives. The remarkable nonoxidizing properties of stellite and its resistance to change under heat were of great advantage to Army surgeons in France. Following advancing lines and attending wounded men close to the front where they could not carry liquid antiseptics, the surgeons sterilized their knives by putting them in a candle or other flame, without destroying the edges or smooth polish. Steel knives would have been destroyed by such treatment. Surgical instruments, valued at about $100,000, and 450,000 pounds of various stellite alloys, valued at $3,000,000, were sold during 1918. In the alloys about 250,000 pounds of cobalt was used. The average price of the tool alloys was $6.50 a pound. Near the end of the year the manufacture of table cutlery and pocketknives was begun, with an initial capacity of 1,000 table knives and 1,000 pocketknives a day. Forks and spoons are to be made at the same rate. Rolls and other machinery for making sheets and wire were ordered for the making of chemical ware, a new stellite alloy said to be very resistant to acids and alkalis having been developed.

Stellite is also made by the Deloro Smelting & Refining Co., Deloro, Ontario.

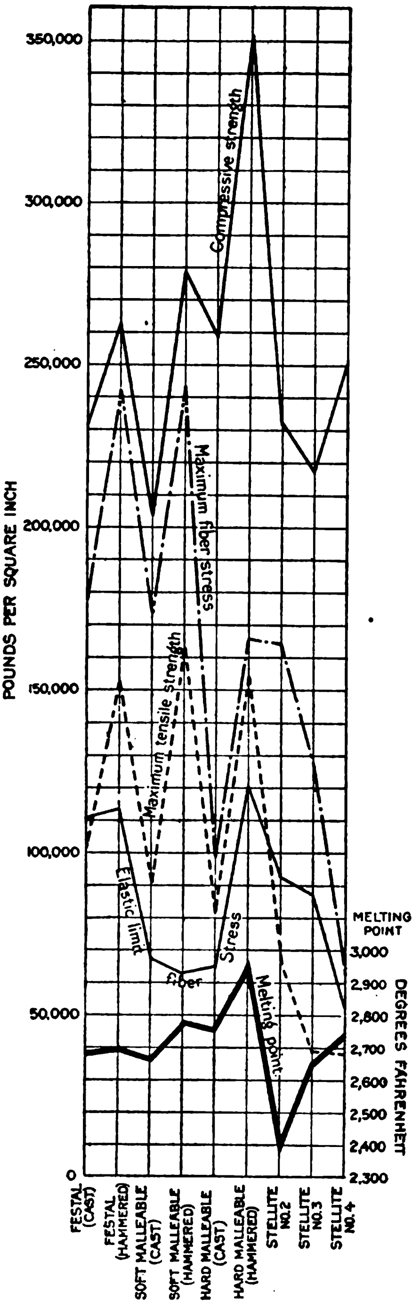

FIGURE 13.—Graph showing tensile and compressive strength, maximum fiber stress, elastic limit, and melting points of various stellites. After graphs made at Purdue University.

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[1] See Cobalt: U. S. Geol. Survey Mineral Resources, 1912, pt. 1, pp. 965–967, 1913.

rious chemicals on stellites.

ter table prepared at Purdue Univer

lic acid, cent solu- ion.[f]	Phosphoric acid, 90 per cent solution.[g]	d 3	xalic acid, 5 per cent solution.[m]	Solution of sodium hypochlorate, U. S. P.
ange....	Tarnished slightly at edges.	N	Corroded some, loss 0.12 per cent.	Slight tarnish at edges, negligible.
o.........	.....do..................	..	Corroded, loss 0.01 per cent	Do.
o.........	No change.............	..	Corroded in spots, loss 0.019 per cent.	No change.
o.........	.....do..................	..	No change.................	Do.
o.........	.....do..................	..	...do......................	Do.
o.........	.....do..................	..	...do......................	Do.
o.........	.....do..................	..	Corroded slightly in spots, loss 0.005 per cent.	Spotted slightly, negligible.
o.........	.....do..................	..	...do......................	Do.
o.........	.....do..................	..	...do......................	No change.

ature.
samples 1 and 2. Others no change.
4, 5, 6 were not changed.

Tests made on stellite of different compositions at Purdue University, Lafayette, Ind., gave the results shown in the accompanying graph and table. Unfortunately the time factor in the table is not given.

COBALT IN MISSOURI.

The cobalt-bearing deposits of southeastern Missouri are thus described by H. A. Buehler:[1]

> The sulphides of cobalt and nickel occur associated with the sulphides of lead, iron, and copper in certain parts of the disseminated lead region of southeastern Missouri. The chief deposits of commercial value occur near Fredericktown, in the southern part of the region. In the Flat River district, to the northwestward of the Fredericktown area, cobalt and nickel sulphides are occasionally recovered as a middlings product on the tables of the lead mills and shipped to smelters for refining.
>
> The ore bodies in the vicinity of Fredericktown occur in the lower part of the Bonneterre dolomite and in the underlying LaMotte sandstone. The ore consists of a mixture of lead, copper, cobalt, nickel, and iron sulphides. The sulphides other than that of lead, occur in greatest quantity in the lower part of the workings, next to and in the sandstone, especially near the granite and porphyry.
>
> The quantity of cobalt and nickel sulphides varies considerably in the different workings. The mines have generally been operated for lead, and nickel and cobalt have been produced as by-products, except from the mines operated by the North American Lead Co.
>
> At Mine LaMotte, cobalt and nickel have been produced in small quantities for many years, even prior to 1857. According to Mr. J. M. McNeill, the chief source of the nickel and cobalt was the dressed galena, which usually carried from 0.2 to 0.3 per cent of these metals. Next in importance was a middlings product of the concentrating plant, which usually carried 20 to 23 per cent lead, 0.5 to 1 per cent of copper and 2.5 to 3.5 per cent of cobalt and nickel. A larger percentage of copper was accompanied by a correspondingly larger percentage of cobalt and nickel. Besides these products of the mill, a small quantity of true cobalt-nickel ore was produced. In recent years, developments in the deeper workings have disclosed the presence of extensive deposits of copper-cobalt-nickel ore.
>
> The chief source of cobalt and nickel in Missouri has been the mine of the North American Lead Co., adjoining Fredericktown. From 1900 to 1906 this property was operated as a lead mine. In exploiting the property large quantities of copper, nickel, and cobalt sulphides were found associated with the lead sulphide. In 1906, the company erected a smelter and refining works for the recovery of the lead, copper, cobalt, and nickel content of the ores. The original plant, with a daily capacity of 100 tons, consisted of one blast furnace, two mechanical roasters, two hand rabbling furnaces, and electrolytic refining plant. Owing to the complexity of the ore, serious difficulties were encountered in both milling and smelting operations. In 1907, the company succeeded in producing 2,731 pounds of cobalt oxide. In 1909, 83,394 pounds of cobalt oxide, 328,403 pounds of nickel, 8,314 tons of nickel and cobalt concentrates, 600 tons of copper, and 1,353 tons of lead concentrates were produced. At this time the ore body being worked is reported to have been 12 feet thick and to have carried 10 per cent copper, 4 per cent nickel and cobalt, and 4 per cent lead. The company's affairs later became so involved that the property was sold at a forced sale in 1910 and remained idle until 1915, when the property was taken over by the Missouri Cobalt Co.
>
> In addition to the properties described above, those of the Hudson Valley Lead Co., Madison Lead & Land Co., and Jackson Revelle Co. are said to carry similar nickel deposits. The Revelle property is located 8 miles south of Fredericktown, while the other two are 4 miles from Fredericktown.

PUBLICATIONS.

The following patents and papers concerning cobalt were issued and published in 1918:

HAYNES, E., Development of stellite: Iron Age, vol. 102, pp. 886–888, 1918; abstract from Chem. Abstracts, vol. 12, p. 2531, Dec. 10, 1918.

In the manufacture of stellite, the chromium, cobalt, and tungsten are melted together in a Snyder electric furnace.

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[1] Buehler, H. A., Biennial report of the State geologist, Missouri Bur. Geology and Mines, pp. 55–56, 1919.

Jones, E. G. (University of Liverpool), A method for the colorimetric estimation of cobalt: Analyst, vol. 43, pp. 317–319, 1918.

Koepp, R., & Co. Enamels. British patent 107392, March 28, 1916. Abstract from Chem. Abstracts, vol. 11, p. 3406, 1917.

In the manufacture of foundation enamels wherein the oxides of cobalt and nickel are employed to secure adhesion, the pure oxides are replaced wholly or partly by ores of the metals, preferably those containing the oxides or carbonates, namely, New Caledonian ores. The ores should be free from sulphur and arsenic, which constituents may be removed by roasting and lixiviation. Ores poor in cobalt and nickel are employed in conjunction with pure oxides, or a mixture of different ores may be used. Examples are given.

Kuehnrich, P. R., Steel. Swiss patent 76814, February 1, 1918. Abstract from Chem. Abstracts, vol. 12, p. 1378, 1918.

A modified steel contains 1–3.5 per cent of carbon, 6–20 per cent of chromium, and 1–6 per cent of cobalt. Small quantities of at least one heavy metal should be present. A specified composition is carbon 1.50 per cent, chromium 12.00 per cent, cobalt 3.50 per cent, silicon 0.30 per cent, manganese 0.20 per cent, phosphorus 0.02 per cent, sulphur 0.02 per cent, iron 82.46 per cent.

Laird, G. M., Electric-resistance alloy. U. S. patent 1257272, February 19, 1918.

An alloy for electric resistances is formed of nickel, cobalt, and silicon.

Lloyd, G. C., and others, Report on the sources and production of iron and other metalliferous ores used in the iron and steel industry, second edition, Department of Scientific and Industrial Research, Advisory Council, London, pp. 120–127, 1918.

A general article on cobalt compiled from available literature. Describes uses, minerals, production, occurrence (by countries). Does not mention the occurrence of cobalt in Katanga copper.

De Rubies, S. Pina, Presence of nickel and cobalt in chromites: Soc. españ. fis. quim. Anales, vol. 15, pp. 61–65, 1917. Abstract by H. S. Paine from Chem. Abstracts, vol. 11, p. 2760, October 20, 1917.

Samples of chromite from many different localities were examined spectrographically for the presence of nickel and cobalt. Most of the rays of the nickel spectrum and many of the rays of the cobalt spectrum were observed in all cases. De Rubies gives data identifying the rays of both the nickel and cobalt spectra which were detected within the limit $\lambda=2270–2370$ (Angstrom) in a chromite from the United States. Nickel and cobalt were also found to be present in the samples of pyroxenite, gabbro, and kazanskite previously analyzed by de Rubies.

Société Amonyme pour l'industrie chimique à Bâle, Dyes. British patent 114189, March 20, 1917. Abstract from Chem. Abstracts, vol. 12, p. 1515, 1918.

Water solutions of copper, chromium, and other metal compounds of hydrazone dyes are obtained by treating with copper or copper compounds, chromium trioxide or salts of chromium, or other metal or metal compound (such as nickel, cobalt, iron, aluminum, cerium, vanadium, or uranium).

Stappenbeck, Ricardo, Cobalto, níquel, arsénico: Dirección gen. de minas, geol. é hidrol. Argentina Bol. 19, ser. B (Geología), p. 73, 1918.

"En el Valle Hermoso, en la falda occidental de la Sierra de Famatina en la mina Reina Alejandra, se encuentran cobaltina, pirita de arsénico, y otros minerales en ganga cuarzosa. Los minerales se hallan en grandes trozos de esquistos talcosos en contacto con rocas efusivas ácidas. Según Hoskold dos análisis dieron:

Cobalto	por ciento	6–7. 01	3–4. 5
Niquel	por ciento	0. 5–2. 5	0. 1–0. 8
Oro	gramos	25–30	10–20
Plata	gramos	150–300	90–180

"Por nuestra experiencia actual, sabemos que en las vetas con minerales de níquel y cobalto se encuentran mayores cantidades de 'pechblende,' caracterizada por su radioactividad, de manera que una investigación exacta de este yacimiento sería de gran interés.

"Una veta de cuarzo con niquelina y annabergita en gneis existe en la mina Solitaria, cerca de Jaguel; otra veta con pirita de arsénico cerca de Real Viejo en La Rioja."

Werner, A., and Karrer, P., Nitrosopentammine cobalt salts: Helvetica chimica acta 1, pp. 54–78, 1918. Chem. Abstracts, vol. 12, p. 1862, September 20, 1918.

Wright, Sidney B., The smelting and refining of silver ore from the cobalt area, and the production and uses of stellite: Canadian Min. Inst. Trans., vol. 21, pp. 269–278, Montreal, Quebec, 1918.

Describes the manufacture of stellite at the works of the Deloro Smelting & Refining Co. (Ltd.), Deloro, Ontario.

MOLYBDENUM.

By Frank L. Hess.

PRODUCTION.

In 1918 the United States still retained its lead as the greatest producer of molybdenum by an output of 431 short tons of metal in 2,280 tons of ore and concentrates valued at $1,253,700. No molybdenum ore is known to have been produced in the years 1911, 1912, or 1913, and only small quantities before that time. In the last five years the output has been as follows:

Molybdenum in ore and concentrates produced, 1914–1918.

Year.	Quantity sold (pounds).	Value.
1914	1,297	$1,297
1915	181,769	114,866
1916	206,740	205,000
1917	350,200	495,350
1918	861,637	1,253,700

In 1918 the center of production moved from Arizona to Colorado. The dumps of the old Mammoth gold mine, from which a large part of Arizona's production had come, had yielded their crop of wulfenite, though the mine is still productive; but the great size of the Colorado deposits and the large mills give an output which is far greater than that of any other State.

GENERAL CONDITIONS.

In 1917 and in the earlier part of 1918 there was a good foreign demand for molybdenum ores and ferromolybdenum, and considerable quantities were used by the Ford Motor Co. and the Carbon Steel Co. in the United States, but the domestic market was very restricted and was supplied during the first part of the year, mostly by the Climax Molybdenum Co. and the Primos Chemical Co.

The Ford Motor Co. had a contract to supply crank shafts and connecting rods for Liberty aircraft engines to the Government, and in these 0.35 to 0.50 per cent of molybdenum was used, with more chromium and nickel. A crank-shaft forging weighed 196 pounds, and an extra shaft was shipped with every 25 Liberty engines. The yield of forging bars was about 60 per cent per heat in the electric furnace, and about 90 per cent of good shafts were obtained from the bars. The connecting-rod forgings weighed about 62 pounds per engine, and each electric furnace heat also gave about 60 per cent of good forging bars but only about 80 per cent of finished forgings from the bars. About 100 crank shafts was the maximum daily output, with presumably an equal number of connecting rods.

During the summer small plates of similar steel exhibited had shown great resistance to light projectiles, and it was proposed to make all armor for tanks and airplanes of similar steel.

The Government did not itself buy any molybdenum ores for the work, but gave its assistance to the companies who were to make the steel in their efforts to obtain ferromolybdenum quickly and guaranteed their contracts. Before the steel was made the company that had advised the use of molybdenum steel announced that it had obtained better results with steel carrying a very small percentage of zirconium, and the company was told to go ahead with zirconium steel if that would afford the best possible protection. Baddeleyite (zirconium oxide) was therefore ordered from Brazil, but before either steel was actually used the armistice was signed and all contracts were nullified.

The greatest single feature of the year in the mining of molybdenum was the building of expensive and elaborate mills by the Climax Molybdenum Co. and the Molybdenum Products Corporation and the development of their holdings on the great deposit on the west side of Bartlett Mountain, at Climax, Summit County, 15 miles north of Leadville, Colo. The mines are at an altitude of about 12,000 feet, the winters are severe, and the snow is heavy, but both companies carried on construction work during the winter. The Climax Molybdenum Co. had its mill sufficiently finished to carry on experimental work in the later part of February and in March. In April the mill was running regularly. The following excerpts are taken from an article by H. L. Brown and M. W. Hayward, entitled "Molybdenum mining at Climax, Colo.," in the Engineering and Mining Journal for May 18, 1918 (vol. 105, pp. 905–907):

> The mine of the Climax Molybdenum Co. is situated on the southwest slope of Bartlett Mountain, 5,000 feet east and 1,000 feet above the company's mill, which is at Climax, Summit County, Colo., on the crest of the Continental Divide, and at an elevation of 11,300 feet. Climax is 15 miles from Leadville, on the South Park branch of the Colorado & Southern Railroad that connects Leadville and Denver. Owing to the altitude, climatic conditions are somewhat severe for practically nine months of the year, but the topography of the country is such that there are no snowslides of any extent, and the mine buildings are so placed as to be immune from such slides as occasionally may be experienced. The mill is built on a relatively flat site remote from any danger of slides.
>
> Extensive deposits of molybdenum on Bartlett Mountain have long been known, but on account of the small demand previous to the war and the failure of several attempts to concentrate the ore, little had been done toward the development of the remarkable surface showings. A 900-foot tunnel was driven in the most favorable surface showings, but this was not done with the idea of developing molybdenite, but had for its purpose cutting a supposed extension of a mineral fault known for its gold values, although this drift has been used as the base for subsequent exploration and development work in that vicinity. Several months were spent by the company in thoroughly sampling the ore deposits as far as exposed and conducting mill tests to determine the best flow sheet. Construction and development were started July 20, 1917, and the first shipment of concentrates was made during February, 1918.
>
> The mine is situated on the northeast side of a glacial amphitheater, the open side of which faces the west, while the sides are precipitous and the lower slopes covered with slide rock. Erosion, due to climatic conditions, has been rapid and has kept pace with oxidation over practically all the mineralized area; sulphides of approxi-

mately the same grade encountered in the underground workings are exposed on the surface. The east end of this amphitheater consists of a granite gneiss, which has been intruded by the granitic rock in which the molybdenite deposits occur.

The ore body is composed of various granitic rocks, which, when the great mass is considered and when it is also considered that the rock is not mashed, is broken into astonishingly small particles. No uncracked piece containing as much as 2 cubic inches was seen in the main part of the ore body. The fragments have been partly replaced by quartz, and after the cracks were nearly filled with quartz, molybdenite was deposited in thin films in most of the tiny veinlets. The article continues:

The molybdenite values are remarkably uniform throughout the ore body.

In all the development work to date, amounting to over 5,000 feet, there have been no blank assays. In the mine workings, including those at a depth of 500 feet from the surface, considerable amounts of yellow oxide of molybdenum are found. Mineralization is invariably confined to fractures, which have allowed oxidation to take place as a result of the circulation of surface waters. Apparently there has been little or no migration of the molybdenum deposition and, therefore, no concentration of values in a zone of enrichment.

No other minerals occur in the deposits, with the exception of a small amount of pyrite. Concentrates containing 75 per cent molybdenum sulphide show less than 0.1 per cent copper, the analysis showing, besides the molybdenite, only insolubles and iron. The ore body is apparently terminated on the northeast by a regular fault dipping 60° NE., but while the present opinion is that this fault is the limit of the ore body, this conclusion has not yet been proved.

Development work of the Climax Molybdenum Co. has been confined to an area of 25 acres of patented ground, although the company holdings comprise in all more than 600 acres. From the mouth of the tunnel back to the fault, an area approximately 1,000 by 800 feet, has been completely blocked out and contains over 6,000,000 tons, averaging 1 per cent molybdenum sulphide. [As shown by longer operation, this estimate seems to be a little too high, 0.8 per cent is probably nearer the actual content.] Another tunnel has been started 200 feet below these workings, and shows ore of the same grade and character. Owing to the dip of the fault, the mineralized area of this tunnel level probably will be nearly double that of the upper level, thus indicating the ultimate development of considerably more ore than now estimated.

The method of mining contemplated calls for a series of parallel stopes, 800 feet long and 25 feet wide, with pillars between of the same width. The stopes will be carried as shrinkage stopes to the surface. After the shrinkage stopes are through to the surface, it is planned to break the pillars down into these stopes. This method is to be adopted wherever a height of 200 feet will carry the stopes to the surface, and where, owing to the contour, it is less than this distance to the surface; the idea being to drive a series of parallel drifts and raises to the surface and gloryhole from the surface to the drifts on the tunnel level.

Surface mining can be carried on only during four months of the year, for while commercial ore outcrops on the surface, with no overburden, the climatic conditions are such that a scheme of mining had to be outlined which would permit underground work during that part of the year when the surface could not be attacked. The ore is ideal for shrinkage stopes, as it contains no talc and breaks short.

The ore now mined from the upper adit is delivered to bins at the mouth of the tunnel, and then carried 500 feet down the mountain by means of a two-bucket tramway to the crusher plant. The elevation of the lower tunnel is the same as that at the crusher plant, and it is planned to eventually bring all of the ore down to this level and to do away with the two-bucket tramway.

The two-bucket tram delivers the ore to 500-ton bins, which discharge direct to a 20 by 10 Blake crusher, where it is crushed to 2-inch size. The ore is then delivered to a conveyor belt, which takes it to a 400-ton storage bin at the upper terminal of the main tramway to the mill. The main tramway is a 5,000-foot Leschen continuous type, having a capacity of 1,000 tons per day, and delivers the ore direct to the mill bins.

The mill was designed by D. F. Haley, and contains an Allis-Chalmers 6 by 6 and 6 by 10 ball mill, Callow and Janney flotation machines, Goldfield agitating tanks for dewatering concentrates, Portland filter and steam drier, with accessory blower, pumps, and elevators. A heating plant and fire pump are housed separately. The present capacity is 350 to 400 tons per 24 hours, and the power is derived from a

13,000-volt line of the Colorado Power Co. The design of the mill is such that it lends itself readily to the installation of additional equipment for increased capacity without interfering with present operations.

The problem of labor supply at this altitude, and with somewhat severe climatic conditions, has been solved largely by the construction of well-built, electric-lighted, steam-heated accommodations for the men, both at the mine and at the mill.

Later in the year the company increased the capacity of its plant to 1,000 tons of ore per day.

The Molybdenum Products Corporation has a patented claim 150 by 1,500 feet located on the same ore body, and had the ore on at least three sides of its claim. It got to work later than the Climax Molybdenum Co. and was not so fortunate in disposing of its product, so that it operated only a short time. The ore body is said to extend southward into Ceresco Mountain, on which the Pingrey Mines & Ore Reduction Co. has located claims, and this extension seems probable, as ore is exposed at the small creek between the two mountains. On the south side of the creek is a great mass of débris so that the bedrock can not be seen for hundreds of feet up the side of the mountain.

As now explored probably 100,000 tons of elemental molybdenum can be mined from the parts of the deposit held by the three companies. The two mills are ready for operation at any time that a demand sufficient to warrant operation arises.

Northwest of Climax the Primos Chemical Co. operates a molybdenite mine at the head of Clear Creek, on the east face of Red Mountain and 14 miles from Empire. The place is known as Camp Urad and is in the Daily mining district. Buildings were erected at the workings 900 feet above the old camp, and an aerial tramway 2,400 feet long was built to carry the ore down to a mill erected early in the year at the base of the mountain. The mill is reported in the press to have a capacity of 200 tons, and oil flotation is used. A tunnel 3,000 feet long is said to have been driven at the base of the mountain to cut the ore body, which is described as occurring in small quartz veins in shattered granite and granite porphyry, and to be especially associated with the porphyry. The deposit contains considerable pyrite.

In Colorado molybdenite was also mined near Gold Hill, 9 or 10 miles north of Pitkin, where the Pennsylvania Rare Metals Mining & Development Co. erected a mill to recover molybdenite, copper, gold, and silver, and extracted a considerable quantity of ore. The Phoenix Works mined and shipped several hundred tons of molybdenite from adjoining claims. On Tarryall Creek, 8 miles north of Lake George, Park County, the United States Rare Minerals Co. erected buildings and took out a quantity of molybdenite ore from the Redskin claim. Bartles, Bryant & Ray took out a quantity of molybdenite ore from their mine in the Grand Island mining district, in Boulder County.

In Arizona both molybdenite and wulfenite were produced by several companies. The Arizona Mines & Reduction Co. mined molybdenite at Skull Valley, but the mine did not prove satisfactory and the company gave up its option. In the Hualpai Mountains, 25 miles south of Yucca, the Arizona Molybdenite Consolidated and the Leviathan Mines Co. mined quartz veins carrying molybdenite, and the latter company reduced part of its ore to ammonium molybdate and calcium molybdate at Los Angeles. Farther north, on the east side of the range, the Standard Minerals Co., which succeeded the Telluride Mining Co., erected a 40-ton mill and made a trial run.

The Helvetia Copper Co., at Helvetia, mined a quantity of molybdenite as a by-product of its copper ores, as did the Duquesne Mining Co. at Duquesne.

The Grand Reef mine, at Klondike, in the Aravaipa mining district; the Rowley Copper Mines Co., at Gila Bend; the Vail Co.'s Total Wreck mine, in the Empire district at Pantano; and the St. Anthony Mining & Development Co. (succeeding the Mammoth Development Co.), at Shultz, all produced wulfenite.

Hereford & Boykin took more concentrates from the old tailings of the Mammoth mine, and Messer and associates recovered still more wulfenite from them by flotation.

In New Mexico a considerable quantity of wulfenite was shipped from the Stephenson-Bennett mine at Organ, and the R. & S. Molybdenum Co. did considerable work on molybdenite deposits near Questa.

In California very little molybdenum ore was produced. Arthur L. Coggins erected a 20-ton mill and flotation plant on Boulder Creek, Shasta County, but found the ore (2.6 per cent of MoS_2) of too low grade to work. F. T. Torpey and others are said to have erected a 40-ton mill on a molybdenite deposit 35 miles east of San Diego. The Imperial Lode Mining & Reduction Co. did a large quantity of work on a wulfenite-bearing property about 7 miles southeast of Lavic.

At El Paso, Tex., the American Smelting & Refining Co. put in a flotation plant and treated a considerable quantity of molybdenite ore from the Continental Mining Co.'s Panuco mine, at Monclova, Coahuila, Mexico. At Nogales, Ariz., the Lower California Metals Co. put up a 100-ton mill and imported molybdenite ores from Sonora.

At Shakan, Alaska, the Alaska Treadwell Co. did a considerable amount of prospecting on a molybdenite deposit, but no shipments were made.

IMPORTS.

No record of imports of molybdenum ores was kept by the Bureau of Foreign and Domestic Commerce before July 1, 1918. During the last six months of 1918, 140,222 pounds of ore, valued at $123,924, was imported. It is known that in the first half of the year 25,000 pounds of molybdenite, averaging about 75 per cent of MoS_2, was imported from Chosen and 19,000 pounds from some undesignated part of Asia. Of molybdenum and ferromolybdenum, 72,925 pounds, valued at $19,280, was imported.

WORLD'S PRODUCTION.

The United States and Canada apparently have the largest known molybdenum supplies. It is believed that the United States has the greatest individual deposits and the greatest quantity of available ore, but neither Canadian nor American Government geologists have examined deposits in both countries, and private opinions differ. The United States has for some years been the largest producer of molybdenum ore and is in a position to increase production greatly whenever the market warrants.

The following table shows the world's production of molybdenum contained in ore, so far as the data are at hand, for the years 1914 to 1918, inclusive. The United States produced none in 1913. No facts are now known that indicate a greatly different distribution in the near future. It is known that some molybdenite has been produced in Germany and some wulfenite in Austria, but the quantities are unknown.

World's output of molybdenum concentrates in terms of the contained molybdenum.

[M=molybdenite; W=wulfenite.]

Country.	Ore mineral.	1915		1916		1917		1918	
		Quantity (metric tons).	Value.	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.
Australia	M	71.9	$377,700	70.39	$314,800	102.05	$456,273	111.8	$500,000
Austria	W	([a])	([a])	([a])	([a])	([a])	([a])	([a])	([a])
Bolivia	M	6.5	5,475	5.17	7,663	([a])	([a])	([a])	([a])
Canada	M	....	....	42.5	156,461	78.5	288,705	102.8	434,528
Chile	M	....	....	.8	....	20.1	9,836	....	....
China	M	([a])	([a])	2.7	1,700	2.4	1,600	1.08	3,689
Chosen	M	....	....	3.2	12,463	59.2	19,034	10.7	25,884
Germany	M	([a])	([a])	([a])	([a])	([a])	([a])	([a])	([a])
India	M	....	....	.4	983	.7	3,050	.09	551
Italy	M	....	....	....	....	.2	([a])	....	....
Japan	M	....	....	18.3	31,177	12.06	30,124	[b] 70.3	12,746
Norway	M	72.3	([a])	73.1	([a])	82.1	533,333	84.9	1,248,804
Peru	M	1.3	6,990	3.08	14,120	3.8	20,970	1.3	7,445
Spain	W	1.8	1,861	....	....	....	....	....	....
Sweden	M	2.2	4,644	.3	1,194	20.3	40,000	25.1	463,629
United States	M W	82.4	114,866	93.8	205,000	158.8	495,350	390.8	1,253,700

[a] Figures not available.

[b] 66.3 tons coarse ore of low grade.

NOTES ON WORLD'S OUTPUT OF MOLYBDENUM.

AUSTRALIA: Mining Jour. (London), Australia: vol. 126, p. 545, 1919.

BOLIVIA:

1916. O'Rear, J. D. (United States minister, La Paz), report dated Sept. 1, 1917. Exports during 1916.

1915. Bolivia—Mineral exports in 1915: Board of Trade Jour. (London), vol. 95, p. 609, 1916. Figures given as 5,191 kilograms, valued at 19,157 bolivianos. This is the first time that molybdenum has appeared in the official list of exports. The mineral is obtained from the Illampu Range.

BURMA:

1916. Briggs, L. P. (United States consul, Rangoon), New gains made in Burma's mineral production: Commerce Repts., Nov. 26, 1917, p. 780.

CANADA:

1916. McLeish, John, Mineral production of Canada during the calendar year 1916, p. 124. Ottawa, Mines Branch, 1918. The MoS_2 content of the concentrates is given as 156,461 pounds, but the weight of the concentrates themselves is not stated. The concentrates from the Mines Branch plant carried 79.95 per cent of MoS_2 so that they are all estimated at 80 per cent of MoS_2. The ore mostly carried less than 2 per cent MoS_2, but small quantities carried 2 per cent to 15 per cent of MoS_2, and some was hand-picked concentrate of higher grade.

1917. McLeish, John, idem for 1917, p. 96. About the same conditions held as for 1916.

1918. McLeish, John, Preliminary report of the mineral production of Canada during the calendar year 1918, pp. 8–9, 1919. "The total production in 1918, representing the quantity paid for, of molybdenite (MoS_2) contents of the ores and concentrates shipped, amounted to 377,850 pounds, which at $1.15 per pound, would be worth $434,528. The amount of ores treated in the concentrating plants was about 33,958 tons, as compared with 22,605 tons in 1917 and 9,106 tons in 1916. Quebec produced in 1918 about 88 per cent of the total, the balance being derived from Ontario, including a very small production from British Columbia."

CHILE:

1917. Anuario estadístico de la República de Chile, vol. 8, Minería y metallurgía, año 1917, p. 11, Santiago, 1918. Molíbdeno (minerales) 41,591 kilograms. valued at 249,546 pesos, from the Province of Tacna. Exported from Arica to the United States.

1916. Resources of the region in dispute between Chile and Peru: Commerce Repts., No. 289, 1918, p. 947. "Ores containing molybdenum, 1,652 kilos, 16,520 pesos."

CHINA:

1918. Pontius, A. W. (United States consul at Canton), Commerce Repts., Sept. 5, 1919, p. 26. Shipment from the Canton district. It is probable that there were some shipments from other districts that are unknown to the writer.

1917. Anderson, G. E. (American consul general, Hongkong, South China), report dated September 25, 1917.

1916. Pontius, A. W. (United States consul at Foochow), report dated April 20, 1917. Exports from Foochow in 1916 totaled 6,500 pounds, valued at $1,700. Exports in the first three months of 1917 were 5,600 pounds, valued at $1,600.

CHOSEN:

1916. Miller, R. W. (United States consul general, Seoul), report dated April 13, 1917. Approximate figures only.

ITALY:

1917. Inspettorato generale delle miniere: Rivista del servizio minerario nel 1917, pt. 1, p. 62. Figures as given "Molibdeno, 0.44 tonnellate."

JAPAN:

1916. Clements, J. M. (United States trade commissioner), report to Bureau of Foreign and Domestic Commerce, December, 1917.

1917. Commerce Repts., February 19, 1919, p. 796. Given as 12 long tons.

PERU:

1915–1917. Jiménez, C. P., Estadística minera del Perú en 1917: Cuerpo ing. minas Perú Bol. 95, p. 218, 1919. The first production was in 1915. The figures as given are for 1915: Exports, 2,740 kilograms of ore containing 2,198.5 kilograms of MoS_2, valued at libras 1,435. 1916: Exports, 5,752 kilograms of ore containing 5,177 kilograms of MoS_2, valued at libras 2,900. 1917: Exports, 7,017 kilograms of ore containing 5,844.7 kilograms of MoS_2, valued at libras 4,309.

SWEDEN: Sveriges Officiella Statistik industri och Bergshantering.

TEST FOR MOLYBDENITE.

The following test is given by F. C. Fuchs[1] (professor of metallurgical chemistry, Lima School of Mines, Lima, Peru):

> During the course of an investigation for molybdenum, I happened to find a most accurate and rapid method of identifying its principal mineral, molybdenite. A small piece of caustic potash is melted in a fragment of a broken porcelain dish and then a little of the suspected mineral is added. Within five minutes, if the sample is molybdenite, it swells, dissolves rapidly, giving the mass an intense red-yellowish color, and not a single speck of the brilliant scaly mineral is to be seen. When cool, if a few cubic centimeters of water be added to the residue of fusion, and afterward some drops of hydrochloric acid, the color begins to change and in spots appear the blue, green, yellow, and red.
>
> The reaction can be explained as follows: Molybdenite (MoS_2), having two atoms of sulphur, gives up one of them to the molten potash and forms a double sulphide of red color, just as the one created in an ammonium-sulphide solution, which is familiar to most chemists. Although the monosulphide of molybdenum has not yet been isolated, probably because of its instability, the indicated reaction tends to prove that it exists in combination with alkaline sulphides.
>
> Molybdenite may also be tested by boiling it with nitric acid or by oxidizing it by heating in the air, then adding one or two drops of concentrated sulphuric acid and boiling almost to dryness, after which the vessel will show, on cooling, a fine blue color near the assay.
>
> Wulfenite does not need oxidation and will give the color on treatment with sulphuric acid only.

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[1] Fuchs, F. C., Identification of molybdenite: Eng. and Min. Jour., vol. 105, p. 991, June 1, 1918.

PUBLICATIONS.

Among the recent patents and literature issued on molybdenum are the following:

Boletín del Instituto Geológico de España, Yacimientos de molíbdeno en las provincias de Granada y Almeria: Vol. 19, 2d ser., pp. 167–193, 1918, 1 map.

Describes wulfenite deposits south of Granada, pages 188–190.

Brown, H. L., and Hayward, M. W., Molybdenum mining at Climax, Colo.: Eng. and Min. Jour., vol. 105, pp. 905–907, May 18, 1918.

An excellent description of the molybdenite mine and mill of the Climax Molybdenum Co. by engineers connected with the company.

Churchward, J., Steel alloy. United States patent No. 1261742, April 2, 1918.

A steel alloy suitable for making automobile frames or gears contains nickel 1–5 per cent, molybdenum 0.25–3 per cent, vanadium 0.15–0.5 per cent, and manganese less than 0.70 per cent.

United States patent No. 1261743 relates to a similar alloy in which titanium replaces vanadium.

Another United States patent (No. 1251341 dated Dec. 25, 1917), covers very similar types of steel.

Galloway, J. D., Northeastern district (No. 2): Minister of Mines, British Columbia, Annual Rept. 1918, pp. K 112–114, 1919.

Briefly describes the new Hazelton Gold-Cobalt Co.'s mine "on the western slope of Rocker Deboule Mountain, 5 miles from Carnaby." (Carnaby is just west of Hazelton at the most northern part of the Grand Trunk Railway.)

A vein carrying gold, arsenic, cobalt, nickel, and molybdenum is from 6 to 18 inches thick. Twenty-seven tons shipped to the Mines Branch, Ottawa, for concentration tests gave assays of: Gold, 1.24 ounces; molybdenite, 1.4 per cent; molybdenum trioxide, 0.18 per cent; cobalt, 1.12 per cent; nickel, 0.60 per cent; arsenic, 8.98 per cent. Gross returns of $2,400 were received. (p. K 25.)

On the northeast side of the mountain, at the head of Mud Creek, a vein carries small quantities of pyrite, chalcopyrite, molybdenite, wolframite and a little gold and silver, but does not seem to be of commercial importance. (pp. K 113–114.)

Haley, D. F., Molybdenite operations at Climax, Colo.: Am. Inst. Min. Eng. Bull., August, 1918, pp. 1183–1188.

Climax, Colo., is on the Colorado & Southern Railway, about 14½ miles northeast of Leadville, and the working tunnel of the Climax Molybdenum Co. is about a mile from the station at an elevation of 12,200 feet above sea level. The ore occurs as an intricate system of fine stringers evenly distributed throughout a large body of silicified alaskite granite. Pyrite is abundantly disseminated through the alaskite. The ore taken to the mill averaged 0.92 per cent MoS_2 (including the molybdic ocher) and 27 per cent iron, with a trace of copper. Rare small bunches of hübnerite are present. The methods of mining and milling are described. A 300-ton mill has been erected, which uses oil flotation. The recovery is 11½ pounds of MoS_2 per ton.

Holland, L. F. S., Recent developments in molybdenum: Min. and Sci. Press, October 19, 1918, pp. 529–531.

The development of the property of the Climax Molybdenum Co., at Climax, Summit County, Colo., has set a new standard of comparison for molybdenite mines in the United States. It has several million tons of commercial ore developed. Operating conditions are difficult because of snow. The purchase and development of the property and the erection of the plant have called for an expenditure of about $600,000. Various parties, including the Climax Co., have claims on the southeast hill.

The part of the Climax Co.'s ore body completely developed measures about 800 by 800 feet, with "backs" said to average about 250 feet. Additional development work from the lower tunnel is expected to increase the ore reserves considerably. The alaskite-granite area, part of which is ore bearing, is limited by its east-west and north-south contacts with the gneiss. In the lower tunnel an east-west contact dips about 70° to the southeast.

From the inspection of a large number of molybdenite deposits, I would guess that the average assay of the Climax ore would be about 0.6 per cent, but molybdenite ores are often deceitful in appearance.

The concentration ratio is 1:125. The extraction is said to be about 70 per cent, or about 11 pounds of molybdenum sulphide to the ton, in a concentrate assaying about 65 per cent of molybdenum sulphide. The endeavor is to keep the pyrite content in the concentrate under 9 per cent. There is practically no chalcopyrite to contend with. The mining costs are understood to be approximately 70 cents per ton and the milling costs about the same. It may be possible, perhaps, to produce concentrate at an operating cost of 40 cents per pound of molybdenum sulphide.

Howe, Henry M., The erosion of guns: Am. Inst. Min. Eng. Bull., February, 1918, pp. 335–339.

(P. 386.) It is reported most persistently and as persistently denied that molybdenum steel is used by our Allies for gun tubes. A like report concerning enemy ordnance led to my having Booth, Garrett & Blair analyze pieces cut from two German guns, with the following results:

10.2–cm. (4-inch) German gun received through Mr. Hudson Maxim:

Carbon	0.372
Silicon	.199
Manganese	.368
Phosphorus	.017
Sulphur	.025
Nickel	2.870
Chromium	1.270

15-cm. (5.9-inch) German howitzer received through Col. N. T. Belaiew, Russian Artillery:

Carbon	0.430
Silicon	.229
Manganese	.218
Phosphorus	.016
Sulphur	.045
Nickel	2.670
Copper	.136
Chromium	1.350
Cobalt	.040

Lloyd, G. C., and others, Report on the sources and production of iron and other metalliferous ores used in the iron and steel industry, 2d ed., pp. 142–149, London, Department of Scientific and Industrial Research, Advisory Council, 1918.

Treats of the uses, methods of concentration, and occurrence of molybdenum in various countries. Repeats the statement that the "chief occurrences of molybdenite are in Australia, Canada, and Norway." Treats briefly of ferromolybdenum.

Mining and Scientific Press, Mining and dressing molybdenite at Climax: Vol. 116, p. 662, May 11, 1918.

The Climax Molybdenum Co. is said to have 222,000,000 cubic feet of ore (10 cubic feet=1 ton) on the southwestern slope of Bartlett Mountain, from which 130 tons give 1 ton of concentrates of 70 per cent of molybdenite. Mill handles 350 tons of ore per day.

Describes milling process, which depends on flotation. Sold 50 tons of concentrates in April for $304,000. Expects to make 90 per cent MoS_2 concentrates.

Molybdenum Products Co., at Buffehr, 1 mile northwest of Climax, ready to operate, is also on Bartlett Mountain. Ore is similar to that of Climax Molybdenum Co.'s and averages 1 per cent of MoS_2. Mill has a capacity of 250 tons.

Pingrey Mines Co. had completed plans for largest mill in field, but is in litigation. An immense quantity of ore is said to be opened up. Summit and Lake counties are fighting in the courts over county line.

Ôkôchi, Masatosi, Majima, Masaichi, and Sato, Naoshi, Molybdenum steel vs. gun erosion: Coll. Eng. Tokyo, Imp. Univ., Jour., vol. 9, pp. 153–195, 1918. Abstract by A. L. Feild from Chem. Abstracts, vol. 13, pp. 833–834, 1919.

An investigation of the physical properties of moybdenum steel and other special steels used for gun barrels, namely, ordinary gun steel, nickel steel, nickel-molybdenum steel, and tungsten steel. Modulus of elasticity: Average value for 7 different samples of molybdenum steel (containing from 0.32 to 1.58 per cent of molybdenum) was 22,178 kilograms/mm.^{2}, about 1.4 per cent greater than that found for ordinary gun steel. Conclusions: The data obtained are not sufficient to determine whether molybdenum steel is preferable as gun material or not.

Poole, W., Molybdenum production, properties, and uses: Australian Chemist and Metallurgist, June, 1918. Reprint, Queensland Govt. Min. Jour., pp. 361–364, August 15, 1918.

A general article on molybdenum minerals, ores, concentration, marketing concentrates, metallurgy, and uses.

Ruder, W. E., High-temperature resistance furnaces with ductile molybdenum or tungsten resistors: Am. Inst. Min. Eng. Bull. 134, pp. 585–591, February, 1918.

Thomson, E., A pegmatite origin for molybdenite ores: Econ. Geology, vol. 13, pp. 302–313, 1918. Abstract by A. B. Peck from Chem. Abstracts, vol. 12, p. 1959, October 10, 1918.

The deposits described are in Pontiac County, Quebec; they are of three types: (1) Associated with the slightly more basic segregations in granite, syenite, and gneiss of the Laurentian. Large amounts of fluorite, pyrite, pyrrhotite, and some tourmaline are present. A pegmatitic origin is evidenced by the dikes near-by. (2) In intimate association with the pyroxene of the "contact pyroxenite" of the Grenville series or in the partly digested rock of this process of silification. There is no direct evidence of pegmatite action, but it is assumed that the carbonate rocks depleted the magma of its silicon dioxide, forming pyroxene and leaving a residue of sulphides and pneumatolytic minerals. (3) Typical pegmatite deposits.

Weitzenkorn, J. W. (assignor to Electric Reduction Co., Washington, Pa., United States patent No. 1287153, December 10, 1918), Steel alloy: Eng. and Min. Jour., vol. 107, p. 336, February 15, 1919.

Steel alloy containing carbon, chromium, vanadium, and molybdenum.

Westling, E. H., and **Andersen**, C., Ferromolybdenum: United State spatent No. 1278408, September 10, 1918. Chem. Abstracts, vol. 12, p. 2313, November 20, 1918.

In making ferromolybdenum, acid containing molybdenum and a ferric salt is neutralized with sodium carbonate or other basic compound to precipitate ferric molybdate, the precipitate is separated from the solution and heated with a reducing agent such as carbon or hydrogen, or both, at a temperature of 500° to 900°.

Wills, C. H., Alloy steel: United States patent No. 1278082, September 3, 1918.

"A steel having a tensile strength ranging approximately from 120,000 pounds to 270,000 pounds and an elastic limit ranging approximately from 100,000 pounds to 225,000 pounds which contains molybdenum in addition to the usual constituents as an added element in quantities ranging from a fraction of 1 per cent to not materially more than 1 per cent, the steel being characterized by workability.

"A steel having a wide range of heat treatment and characterized by workability, substantially containing carbon from 0.20 to 0.35 per cent; manganese from 0.30 to 0.125 per cent; chromium in relatively large traces up to 1.20 per cent; silicon from 0.15 to 0.35 per cent; and molybdenum in relatively large traces up to 1 per cent."

Wills, C. H., Chrome steel: United States patent No. 1288344, December 17, 1918.

A case-hardening steel is formed of the usual constituents with the addition of about 1 per cent or less of molybdenum which renders it possible to accomplish refining of the case and core simultaneously. The steel may contain carbon 0.06–0.18 per cent, manganese 0.20–0.75 per cent, chromium 0.75 per cent, silicon 0.10–0.40 per cent, and molybdenum 1 per cent or less.

Wills, C. H. Spring steel: United States patent No. 1288345, December 17, 1918.

A "heavy-duty" spring steel is formed containing carbon 0.38–0.55 per cent, manganese 0.40–1.25 per cent, chromium 2 per cent or less, silicon 0.10–0.40 per cent, and molybdenum 1 per cent or less. The steel preferably is drawn at a temperature of about 570°.

Wilson, M. E., Molybdenite deposits of Quyon district, Quebec: Canadian Mining Manual, 1918, pp. 210–211, 2 photo. reps., Toronto, Mines Publishing Co., 1403 Canadian Pacific Railway Building.

Gives a history of operations and a description of the geology of the molybdenite mines near Quyon, Quebec.

Woakes, E. R., Molybdenite in Norway: Inst. Min. Met., vol. 160, pp. 1–12, 1918. Reprinted Min. Jour. (London), vol. 120, pp. 65–67, 1918; also in Eng. and Min. Jour., vol. 105, pp. 499–502, March 16, 1918.

Gives a list of 28 prospects and mines, by district and owner, and then very briefly describes the occurrences.

Says that 160 tons of concentrates were produced in 1916, but gives no per cent of molybdenum or molybdenite. The Mining Journal states that 158 tons of molybdenite was produced in 1915.

The Knaben No. 1 mine in the Knaben district contained some very rich ore. One piece weighing more than 4 hundredweight was given to Sheffield University. Mine has averaged 5 tons of 75 to 90 per cent of molybdenite per month. The hanging wall is gneissic granite and the footwall more or less porphyritic. The vein is quartz. At the Kvina mine "on the same mineral belt" and 1 mile north, the vein is accompanied in places by pegmatite, and the granite is impregnated with molybdenite. Ore averages 0.3 or even less (molybdenite). The Knaben No. 2, (2 miles south of No. 1), is on granite gneiss, in which molybdenite is found along joints and impregnated in the gneiss, through several hundred feet in length and in places to a width of more than 100 feet, and it is thought that it will mill 0.5 per cent of molybdenite.

The Gursli mine in the Moi district is on a vein in norite (?) and carries mica and chalcopyrite.

The Orsdal mine at Siredalen carries a little wolframite with the molybdenite.

The Dalen mine, at the west end of Lake Bandaks, Telemarken district, was the largest Norwegian producer in the early part of 1917. It is on a flat white quartz vein, a few inches to 3 feet thick and 200 feet long, in slate. Produces some hand-picked material.

Mentions several smaller properties, and thinks that if the price does not go below 80 shillings per unit of molybdenite the mines will produce 100 tons per annum (presumably concentrates).

A sketch map shows the deposits to be in the peninsula west of Christiania and south of an east-west line drawn through that city.

Wolf, H. J., Tests for molybdenum: Min. and Sci. Press, 1918, p. 624.

A summary of tests given in a circular issued by the Colorado School of Mines. Among others the following tests are given: Fuse the finely powdered ore with equal parts of sodium carbonate and potassium carbonate and a little potassium nitrate. Powder the melt, dissolve with hot water, and filter. Acidify the filtrate with hydrochloric acid, boil, and add KCNS or NH_4CNS, and a small piece of metallic zinc. If molybdenum is present a bright cherry-red color has developed, the color disappears, returning as soon as the hydrogen dioxide has been reduced. If the amount of molybdenum present is known to be small, this test may be made more delicate if, immediately after the thiocyanate and zinc have been added to the acidified filtrate from the leached melt, the solution be shaken with a small volume of ether. The color will be intensified as a golden brown in the ether ring that forms at the top of the liquid on standing. With borax in the oxidizing flame it gives a colorless glass, which, in the reducing flame, becomes opaque black or dirty green. Strong hydrochloric acid gives a green solution which, when diluted and stirred with tin, becomes deep blue and finally brown. On evaporation with hydrochloric acid, if the residue is moistened with water and zinc is added, a deep-blue solution results, which persists after dilution.

Wood, H. E., Recovering metals from ores by flotation: United States patent No. 1264503, April 23, 1918. Abstract from Chem. Abstracts, vol. 12, p. 1638, 1918.

Dry crushed ore, which may contain molybdenite pyrrhotite, is concentrated by the film tension flotation process, the concentrates are heated to oxidize undesirable components such as iron sulphide and the oxidated concentrate, mixed with a small amount of oil, is passed to a flotation tank and on the way to this tank is exposed to air by intermittent air blasts. The metals are then recovered from the oiled concentrate by flotation.

Yancey, H. F., Ilsemannite: Chem. and Met. Eng., vol. 19, pp. 186–190, August 15, 1918.

Gives the history of ilsemannite and the following analysis of material from Ouray, Utah:

Silica (SiO_2)	0. 98
Alumina (Al_2O_3)	10. 62
Ferrous oxide (FeO)	9. 58
Titania (TiO_2)	Trace.
Calcium oxide (CaO)	1. 24
Magnesium oxide (MgO)	1. 36
Sulphur trioxide (SO_3)	38. 48
Molybdic oxide (MoO_3)	23. 85
Chlorine (Cl)	. 17

The above work does not constitute a basis for the proposal of a formula for ilsemannite. The formula proposed ($MoO_2.SO_3.3H_2O$) is not supported by the present investigation. Muthmann's formula ($MoO_2.2MoO_3$) more nearly fits the properties of the compounds as determined but requires perhaps too much reduced molybdenum. Guichard has shown the formula of Muthmann for the synthetic blue oxide ($MoO_2.2MoO_3.xH_2O$) to be inaccurate; that it really is $MoO_2.4MoO_3.6H_2O$. But even Guichard's formula does not fit the blue of ilsemannite completely; as the water-soluble portion of the molybdenum in the ore does not contain sufficient reduced molybdenum. However, it is preferable for the present to consider the ore examined as a mixture containing the original parent molybdenum mineral, and water-soluble ilsemannite of Guichard's formula together with other water-soluble oxides of molybdenum formed in the alteration process.

TANTALUM.

By Frank L. Hess.

For several years prior to 1918 there had been no market for tantalum or columbium minerals, and they had therefore not been produced. There had, however, been a continuously active interest in research in all lines of metallurgy, and, as its name suggests, this element has tantalized the investigator with its attractive qualities, such as resistance to the action of most acids and many other chemicals and to the air, high tensile strength, malleability, and high melting point, coupled with great difficulty in separating it from its twin element, columbium, and from oxygen. Tantalum has been made into a ferroalloy and introduced into steel and has seemed to give the steel desirable properties. Alloys of tantalum, columbium, and other metals have also given investigators much interest, and columbium chloride, when introduced into the mercury arc, gives red lines that correct the disagreeable greenish-blue color that prevents more extended use of the arc. Through brilliant work by Von Bolton, a Pole, tantalum was used as a filament in an incandescent lamp that was much better than any preceding lamp and was prevented from displacing the carbon filament lamp only by the development of the tungsten lamp, which is much more efficient than the tantalum lamp and drove it from the market.

The demand for tantalum and columbium salts for experimental purposes finally became large enough to allow A. T. Roos, of Deadwood, S. Dak., to market 4,500 pounds of columbite, valued at $2,250. The columbite, which carried about 50 per cent Ta_2O_5, was taken from the pegmatite dike on the Bob Ingersoll claim, a few miles west of Keystone, S. Dak., on the road to Hill City. The dike carries also albite, lilac-colored lepidolite, cassiterite, green tourmaline, quartz, and muscovite. With some of the columbite were pieces of pitchblende the size of a pea, and a little gummite and uranophane, evidently formed through the decomposition of the pitchblende. Some very large masses of columbite have been found in the Bob Ingersoll dike. Blake[1] states that a mass weighing 2,000 pounds was found in the dike in the eighties. Many other dikes in the vicinity around Custer and Nigger Hill also carry columbium and other tantalum-bearing minerals, including strueverite, a tantalum-columbium-titanium mineral. A considerable quantity of the minerals is available, but just how much will depend on the price, quantity desired, and percentage of tantalum demanded. The pure tantalite and other tantalum minerals free from columbium are unknown in this country except as mineralogic curiosities.

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[1] Blake, W. P., Tantalite and columbite in the Black Hills of South Dakota: Am. Inst. Min. Eng. Trans., vol. 13, pp. 696-697, 1885.

TITANIUM.

By Frank L. Hess.

PRODUCTION.

Rutile, titanium dioxide (TiO_2) and ilmenite, titanium iron oxide ($TiFeO_3$), were produced in this country in 1918 by the American Rutile Co., at Roseland, Nelson County, Va. The company sold 261 short tons of rutile concentrates, carrying 95 per cent of TiO_2, valued at $39,150, and 444 tons of ilmenite concentrates, carrying 55 per cent of TiO_2, valued at $11,100. The ilmenite is obtained as a by-product of the rutile.

At Pablo Beach, Fla., Buckman & Pritchard (Inc.) built a large new plant to separate rutile, ilmenite, monazite, and zircon from the beach sand. No rutile was sold during the year, but about 1,200 tons of ilmenite was produced and shipped to the Titanium Alloy Manufacturing Co., at Niagara Falls, which owns a large part of the mining company. The Titanium Alloy Manufacturing Co. has for a number of years made ferrotitanium by the electric-furnace method and has also made many experiments in the production of titanium dioxide for use as a white pigment, and W. T. Meredith, the president, reports that the company has spent $500,000 on a plant for its manufacture. The company apparently uses about 1,200 tons of ilmenite a year.[1]

Nearly all the rutile produced was taken by the Government for the manufacture of titanium tetrachloride for smoke screens. Titanium tetrachloride ($TiCl_4$) is a liquid that fumes rapidly and has a great avidity for water, which it takes from the air so quickly that dense white fumes of titanium hydroxide(?) are formed and hydrochloric acid is set free. Ammonia fumes mixed with those of the titanium tetrachloride form ammonium chloride, adding to the denseness of the cloud, so that steamers or troops can be well hidden.

In April, 1918, representatives of the Bureau of Mines and of the United States Geological Survey were sent to study the rutile deposits of both companies, but almost simultaneously a contract was sent to Buckman & Pritchard (Inc.) for 410 tons of rutile at $90 a ton, so that their report had no influence on the award, and an advance of about $12,000 was later made to the firm. The corporation represented that it could begin production within six weeks after receiving the formal contract, but the representatives of the two bureaus rendered an opinion that six months would be required to begin deliveries. The firm was unable to deliver any rutile before the signing of the armistice and made no sales of rutile during the year, though ilmenite is said to have been shipped, as already stated.

The American Rutile Co.'s mill was not adequate for a large increase in production, but fortunately phosphorus in some quantity and silicon tetrachloride in large quantity were available and could be used as substitutes for titanium tetrachloride.

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[1] Testimony before the War Contract Adjustment Board.

Titanium minerals produced in the United States, 1910–1918.

Year.	Rutile concentrates.		Ilmenite concentrates.		Total value.
	Quantity (short tons).	Percentage of TiO_2.	Quantity (short tons).	Percentage of TiO_2.	
1910	566	75–98			$44,480
1911	(a)	(a)	(a)	(a)	(a)
1912	275	80–85			27,500
1913	305	94–96			49,000
1914	94	95.	89	55	16,175
1915	250	94–96	300	55	27,500
1916	110	95	95	55	18,400
1917	206	93	1,339	53–65	45,637
1918	261	95	1,644	53–55	57,750

[a] No production.

PRICE.

The average price of rutile concentrated to 93 to 95 per cent of TiO_2 has ranged around $150 a ton. The American Rutile Co. has obtained about $25 a ton for its ilmenite, because it seems for some unexplained reason to be especially adapted to the making of electrodes, and the Thermit Metal & Alloys Co. has also found it best adapted to its process for making carbon-free ferrotitanium. On the other hand, the Titanium Alloy Manufacturing Co. has found ordinary ilmenite sufficient for its needs and paid $6.25[1] for the ilmenite from the Florida sands.

USES.

The production of rutile has heretofore been wholly in the hands of the American Rutile Co. because the demand has been so small that it was not profitable for others to operate, and the deposits of that company are very large. Titanium in the form of ferrotitanium is used in steel and in cast iron as a scavenger to remove oxygen and nitrogen and as an alloy. (See United States patent No. 1261743 to James Churchward, dated Apr. 2, 1918.) For a number of years it was used in steel rails, but this use seems to have lapsed, and it is now used in cast steel and cast iron to give a more homogeneous structure. Ferrotitanium is almost wholly made from ilmenite, although rutile has been used for the purpose.

Rutile is used as a constituent of electrodes for arc lamps, for making potassium-titanium oxalate, used in tanning and dyeing leather and in dyeing textiles, and for coloring glazes of pottery and enamels, both in chemical combination and as a mechanical mixture. A little rutile has also been used in making glass.

Titanium as an element is difficult to isolate and has so far not been put to practical use. It is made by heating titanium oxide and metallic sodium in a bomb.

IMPORTS.

The titanium imported for consumption in the United States in 1918—for six months beginning July 1—amounted to 1,606 pounds, valued at $221.

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[1] Testimony before the War Contract Adjustment Board.

RADIUM, URANIUM, AND VANADIUM.

By Frank L. Hess.

PRODUCTION.

The output of uranium and vanadium ores in 1918 amounted to about 18,860 short tons, containing 27.1 grams of radium (Ra), 89.5 tons of uranium (105.5 tons of U_3O_8), and 276 tons of vanadium. Any value given to the output must be arbitrary and open to question, for the larger part of the uranium ore was produced by companies which themselves used the ore, and the vanadium ore was produced only by the Primos Chemical Co., which also reduced the ore, and by the Colorado Vanadium Co., which sold its ore to the Primos Chemical Co. Although there is a market for carnotite ore ($K_2O.2UO_3.V_2O_5.8H_2O$), which gives a basis for estimating the value of other similar ores, there is none for vanadium ore. The approximate value, as ore, was probably about $957,000. More than 21.7 grams of radium in various salts was isolated during the year.

GENERAL CONDITIONS.

The outstanding features of the production of radium, uranium, and vanadium in 1918 were the opening at Lusk, Wyo., of uranophane deposits, a type of uranium ore not heretofore found, uranophane having been known only in very small quantities; the largest production of radium salts yet isolated; the continued production of radium from uvanite; the discovery through drilling of carnotite deposits well back from the edges or "rims" of the mesas on which the deposits are mined; and the increasing price of vanadium.

RADIUM AND URANIUM.

DOMESTIC PRODUCTION.

At Lusk, Wyo., uranium was found accidentally in the dump of a mine worked long before for silver. The land containing the old mine is said to have been bought for an addition to Lusk. The hill in which the old workings were situated was taken as an undesirable bit of land that could not be separated from the more desirable part. After the discovery of uranium there was strong competition for a lease on the property, and it was finally obtained by the Lorimer Minerals Co. at an exorbitant rate. Several cars of ore was mined and shipped to the Radium Co. of Colorado, at Denver.

The ore is in a quartzitic sandstone, said to be the Dakota sandstone, and is stained black, yellow, and green. The green color is due to copper, probably in the form of malachite; the yellow is due to uranophane, a uranium silicate, and there is also a little orange gummite, another uranium silicate. Some of the black ore is said to be rich and some lean in uranium, and it is not yet certain to what the color is due. It had been thought from analyses that the uranophane was a uranium oxide, but optical examination by E. S. Larsen, of the United States Geological Survey, showed it to be typical uranophane. Several cars of ore was shipped, and a part, at least, carried more than 4 per cent of U_3O_8. Prospecting for further deposits was actively prosecuted, but none are known to have been found.

As noted at the beginning of this article, 21.7 grams of radium (Ra), mostly in the form of chloride but partly as bromide, was isolated during the year. This is much the largest annual production ever made. Of it the Standard Chemical Co. saved 13.6 grams. Since 1913 the Standard Chemical Co. has isolated the following quantities of radium:[1]

Radium produced by the Standard Chemical Co., 1913-1918.

	Grams.
1913	2.1
1914	9.6
1915	1.7
1916	5.0
1917	7.0
1918	13.6
	39.0

The Chemical Products Co., of Denver, continued to isolate radium from the uvanite (hydrous uranium vanadate) obtained from Temple Rock, Emery County, 45 miles southwest of Green River, Utah, and bought the claims of Browning & Beebe. This company also bought the carnotite (hydrous potassium-uranium vanadate) claims of Ike Stevens, at Cedar, Colo.

In the carnotite fields of Long Park, Colo,, and adjacent areas, drilling was actively continued in the search for new deposits, and it was shown that the theory held by some, that deposits were only to be found near the outcrops of the sandstone, was erroneous. Concerning operations in the Colorado uranium fields, a letter from John I. Mullen, field manager of the Standard Chemical Co., is quoted in part by Fred Carroll, commissioner, in the Fifteenth Biennial Report of the Bureau of Mines of the State of Colorado, pages 114–115 (1919), as follows:

> During the year 1918 there has been mined in Paradox radium field, 8,450 tons of carnotite ore, averaging about 2 per cent of uranium oxide and 3½ to 4 per cent of vanadium oxide. Of this, the Standard Chemical Co. has mined 6,800 tons. * * *
>
> The Standard Chemical Co. employed an average of 200 men daily; the Luminous Materials Co. gave work to 45 men daily; the Radium Co. of Colorado employed 35 men; Picket and associates worked about 25 men.
>
> The Standard Chemical Co. has 375 mining claims in Colorado; the Luminous Materials Co. has about 60 claims; Radium Co. of Colorado has about 40 claims; Picket and associates have about 40. The Cummings Chemical Co., which has not operated here during the past three years, owns about 35 claims.
>
> During the past three years, and especially during the past year [1918], there has been practically no prospecting for carnotite properties. The writer knows of only four individuals that have spent any time prospecting, and I don't suppose they average over two months in the year looking for the rare metal. This is very probably due to the fact that the mining of carnotite ore is not very profitable for the poor man. The

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[1] Viol, C. H., Radium production: Science, vol. 49, p. 227, Mar. 7, 1919.

experience I have had shows that in order to make anything in the mining of carnotite ore, one must go on through with it and sell the finished product, such as the radium, uranium, and vanadium. The open markets pay very little for carnotite ore, and I might say that the small miner or prospector gets but very little for the ore after he has it sacked. * * *

The average haul from the carnotite field to the railroad is 60 miles. Cost of transporting carnotite ore to the railroad is 39 cents per ton-mile. The roads are narrow, on steep grades, and have many sharp curves. Some of these curves have radii of 25 feet; in spite of this there have been some eight or nine trucks operating during the past year, hauling ore from the radium fields to the railroads. If the roads are not improved, it will never be any more economical to transport ore by trucks than it will be by horsepower.

The production of carnotite ore is beginning to be a fixed mining proposition in Colorado. During the past three years the Standard Chemical Co. has drilled 52,000 linear feet in testing this country for carnotite deposits. The largest pocket we have found gave up 52,000 sacks (which is about 2,080 tons). This pocket was about one-quarter of a mile back from the rim and about 30 feet under the surface, the overburden being solid sandstone. I might further mention that this body of ore was found by a Sullivan D. P. 33 drill. With this machine the Standard Chemical Co. has devised means to put down dry holes to a depth of 30 feet.

Of the above referred to 52,000 feet, about half of this footage was drilled by D. P. 33 drills, the holes varying in depth from 15 to 30 feet. 26,000 feet was drilled with diamond drills. * * *

The Standard Chemical Co. is investigating the possibility of moving its radium extracting plant from Pittsburgh to Denver. Before the European war the question of chemicals was a big drawback, but certain changes have taken place in the chemical world during the past two years, and it looks to me as though we can get our extracting plant closer to our mines.

The United States Metals Reduction Co. erected a dry concentrator for carnotite ores on its claims just inside the Utah line, not far southwest of Gateway, Colo.

In December nearly full-page advertisements appeared in the papers of Denver and Salt Lake City announcing the discovery of pitchblende in the fluorspar deposits near Jamestown (ordinarily known as "Jimtown"), Boulder County, Colo., and offering for sale stock in the Colorado Pitchblende Co., which had acquired control of the deposits. A committee of the Boulder Commercial Association, composed of W. F. Bleecker, R. D. George, and John B. Ekely, investigated the deposit and found it too lean for profitable mining for its radium content. The Denver Civic Association and the Colorado Manufacturers Association appointed two mining engineers, Messrs. MacCarthy and McClave, to investigate the deposit, and their report was not much more encouraging. The company claimed that the ore carried 0.1 per cent of uranium oxide and 2 per cent of lead.

When the property was visited early in March, 1919, by G. F. Loughlin, of the United States Geological Survey, a little fluorspar was being mined, and the Golden Age mill was being overhauled. Success of the enterprise then appeared dependent upon the market for western fluorspar, as the metal contents of the deposits were too low to warrant concentration except as a by-product, and the recovery of pitchblende was only in the experimental stage. The latest information[1] is that a bank whose cashier had accepted drafts from the president of the Colorado Pitchblende Co. had been obliged to suspend operations and that the president was a fugitive from justice.

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[1] Min. and Sci. Press, June 7, 1919, p. 792.

IMPORTS.

Uranium salts and oxide, including some radium salts, imported for consumption, 1913–1918.

Year.	Value.	Year.	Value.
1913	$34,319	1916	$5,065
1914	63,055	1917	2,930
1915	17,288	1918	[a] 274

[a] Radium salts only.

In addition, 157 pounds of "uranium-radium steel-hardening ores," valued at $4,840, was imported in 1918.

EXPORTS.

About 3 grams of elemental radium in salts is known to have been exported during 1918.

NOTES ON CONSERVATION.

The United States is occupying a more and more important place in the production of radium, for the Austrian deposits are apparently nearly exhausted, the Cornish deposits have not so far proved to be of much importance, the known deposits of both Portugal and Australia are small, and the only others of any great size now known are the deposits of tyuyamunite (hydrous calcium-uranium vanadate) in Russian Turkestan, at Tyuya-Muyun Mountain, in Ferghana.

It is a source of regret that this unique element is not under such control as to be conserved in proper quantities and in such places as to make its use the most beneficial to the suffering. Its palliative and curative properties in some forms of cancer, lupus, eczema, fibroids, birthmarks, and other diseases and abnormalities are so wonderful when compared with other agencies at our command and the supply is so distressingly limited that it is greatly feared that the necessity for its conservation may not be recognized until the possibility has passed.

At present comparatively large quantities of radium are being used on watches of the poorest sort, and during the war other large quantities were used in many instruments, but the necessities of war did not permit other control. However, outside of these uses radium salts are apparently being scattered widely in quantities of a very few grams. Such quantities are too small to be of real use and may possibly be of real harm by giving patients false hope and leading them to put off other treatment too long.

For the uranium salts saved as a by-product there is little market, and one firm wrote that it was no longer saving these salts. It is to be hoped that as little as possible will be wasted, for the day will probably come when uranium salts will be needed, though possibly that day is so far away that it will not bring profit to the firms now isolating radium.

The prices for radium during 1918 apparently ranged from $100 to $120 a milligram. For vanadium salts saved as a by-product in the isolation of radium there was an increasing demand at $1 to $1.15 for the metal contained in the oxide or the iron vanadate.

VANADIUM.

MODES OF OCCURRENCE.

The minerals of vanadium are the sulphide, patronite; the oxidation products, vanadinite, descloizite, dechenite, psittacinite, and related minerals found in the oxidized parts of lead and copper veins, carnotite, and roscoelite (a vanadium mica). It is also present in unknown form and small fractions of 1 per cent in ilmenite, some asphaltities, and some iron ores, such as the minette ores of northeastern France and other iron ores of France.

Patronite, now the most important vanadium ore, furnishing probably two-thirds of the world's vanadium, is found at only one place, Minasragra, Peru, where it occurs in a single mass of asphaltic material with a roughly lenticular horizontal section in sedimentary rocks. The depth to which it extends is unknown. Carnotite is found in this country in flatlying soft sandstone beds, as a deposit formed by the replacement of wood or other vegetable remains, now fossilized, and as material impregnating the sandstone. Roscoelite occurs as a thin flat vein and as an impregnation in flatlying sandstone near Placerville and Vanadium, Colo. Vanadium minerals, probably closely related to roscoelite, occur with the carnotite.

Many ilmenites, segregations from igneous rocks, carry a small fraction of 1 per cent of vanadium but have not yet been worked for vanadium.

IMPORTS.

Vanadium ore imported during the last six months of 1918 amounted to 1,772,215 pounds, valued at $5,333. No separate record was kept prior to July, 1918.

WORLD'S PRODUCTION.

One-half of the world's vanadium comes from Peru. Most of the other half comes from the roscoelite and carnotite fields of southwestern Colorado and southeastern Utah. Small quantities of dechenite and other oxidized vanadium minerals have also been obtained in New Mexico, Nevada, and Arizona. A little mottramite has been mined in the former German East Africa, now under English control; tyuyamunite, a calcium carnotite, has been mined in Russian Afghanistan and treated at Petrograd; and vanadium has from time to time been extracted from the French iron slags.

The United States, as the largest steel-making nation, is the largest user of vanadium. England, Germany, and France buy ferrovanadium from this country and also buy ores when possible.

The Minasragra deposit is owned by an American company, the American Vanadium Co., but of course the political control is wholly in the hands of Peru.

The exports from Peru and the production in the United States since 1912 have been as follows:

Approximate world's production of vanadium, 1912–1918.

Year.	Peru (ore).			United States (ore and concentrates).
	Quantity (metric tons).	Percentage of V_2O_5.	Vanadium contained (metric tons).	Vanadium contained (metric tons).
1912	3,048	45.00	768	272
1913	None.			392
1914	14.5	45.00	4	410
1915	3,145	45.58	793	569
1916	3,448	40.00	773	417
1917	4,083	35.78	819	439
1918	2,183	19.10	234	250

TECHNOLOGY.

In a general way the sulphide patronite is roasted and fused with a soda salt to form sodium vanadate, which after extraction is smelted in an electric furnace to ferrovanadium carrying between 35 and 40 per cent of vanadium.

The vanadates of lead, copper, and zinc are commonly fused with a soda salt, the lead separating as metal and the vanadium going into the slag as sodium vanadate, from which point the general process is the same as for patronite.

In the treatment of carnotite for radium, vanadium is separated as oxide or iron vanadate, which is reduced in the electric furnace to ferrovanadium.

Roscoelite-bearing sandstone is roasted with salt and pyrite, lixiviated, filter-pressed, the solution treated with a ferric salt to precipitate the vanadium, the precipitate filtered out, and the ferric vanadate smelted in an electric furnace to ferrovanadium.

Some asphaltite has been burned in Peru and the ash shipped to the United States for treatment, presumably by fusing with soda, and so on.

In smelting the minette ores of France, the vanadium is carried into the slag and is extracted from that.

USES.

The one use that makes vanadium of large economic value is as a scavenger and alloy in steel. Added to steels in quantities of 0.25 to 1.50 per cent, it is said to remove occluded oxygen and nitrogen and also to combine with the steel. In the smaller quantities, it is said to give great toughness and is used in steels for automobile axles and other parts on which severe strains come, for locomotive tires and frames, and in similar steels. The larger quantities are used in high-speed and other tool steels. Its use is now as standard as that of tungsten in high-speed steels. Small quantities of vanadium have been used in dyes and medicines, and still smaller quantities for other purposes.

In the manufacture of steel, efforts are now being made to use molybdenum as a toughener and titanium as a scavenger as substitutes for vanadium, but these substitutes are not common. Titanium has been used in cast steels, though not with entire success. In tool steels, tungsten, chromium, molybdenum, and cobalt, all or some, are also added.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN COLORADO.[1]

(MINES REPORT.)

By CHARLES W. HENDERSON.

PRODUCTION.

GENERAL STATEMENT.

The total value of the gold, silver, copper, lead, and zinc produced in Colorado in 1918 was $34,160,172, a decrease of 19 per cent from the value in 1917. Of this total value, represented 37 per cent gold, with an output of $12,751,718, a decrease of $2,977,506, which followed a decrease of $3,424,597 in 1917 and a decrease of $3,261,123 in 1916. The silver produced decreased 240,799 ounces in quantity but increased $1,044,767 in value, which amounted to $7,063,554.

The copper produced, mostly in connection with the recovery of other metals, was 6,277,332 pounds, valued at $1,550,501, a decrease of 1,844,672 pounds in quantity and of $666,806 in value. Lead, which amounted in value to $4,683,214, decreased 2,029,252 pounds in quantity and $1,163,927 in value. The zinc produced, which was valued at $8,111,185, represented 24 per cent of the total; it showed a decrease of 31,181,874 pounds in quantity and of $4,161,024 in value.

Metals were produced in Colorado from 576 deep and 12 placer mines in 1918 as compared with 715 deep and 33 placer mines in 1917. Most of the 160 mines that stopped production are in Boulder, Clear Creek, Ouray, Saguache, and Summit counties.

ORE.

The quantity of ore from Colorado mines sold or treated in 1918 decreased 373,816 short tons as compared with 1917.

In 1918 amalgamating and cyaniding mills, with or without concentration equipment (including all the custom mills of the State), treated 1,345,451 short tons of ore and made an average recovery of 0.338 ounce of gold and 0.257 ounce of silver to the ton. From this ore and from 555,262 tons sent to concentration and separation mills—a total sent to mills of both classes of 1,900,713 tons (82 per cent of the total quantity treated as against 81 per cent in 1917)—there were produced 226,292 tons of concentrates, the ratio being 8.4 to 1.

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[1] For discussion of the geology of the districts mentioned in the following pages the reader is directed to the bibliography given in Mineral Resources, 1912, pt. 1, pp. 704-705, 1913, and to U. S. Geol. Survey Bull. 507, The mining districts of the western United States, by J. M. Hill, with a geologic introduction by Waldemar Lindgren, 1912.

The crude ore shipped to lead and copper smelters amounted to 350,690 tons averaging 0.16 ounce of gold and 12.26 ounces of silver to the ton, 0.53 per cent of copper, and 4.22 per cent of lead. The crude ore sent to smelters and zinc oxide plants amounted to 63,487 tons averaging, according to the original assay, 22.78 per cent of zinc.

The concentrates of all classes sent to lead and copper plants amounted to 132,144 tons and yielded averages of 0.60 ounce of gold and 16.46 ounces of silver to the ton, 0.85 per cent of copper, and 11.40 per cent of lead. The zinc and zinc-lead concentrates shipped to zinc retort smelters and zinc-oxide plants amounted to 94,148 tons averaging 43.52 per cent of zinc. The crude ore and concentrates combined shipped to lead and copper plants therefore amounted to 482,834 tons averaging 0.28 ounce of gold and 13.41 ounces of silver to the ton, 0.62 per cent of copper, and 6.18 per cent of lead. The crude ore and concentrates combined shipped to zinc retort smelters and zinc-oxide plants amounted to 157,635 tons carrying 28.27 per cent of zinc (original assay).

In 1918 there were 12 productive placers in Colorado, which yielded $526,202 in gold and 6,650 fine ounces of silver, valued at $6,650, a total of $532,852, as compared with $667,869 in 1917.

Mine production of gold, silver, copper, lead, and zinc in Colorado in 1917 and 1918.[a]

	Number of producing mines.	Ore.	Gold.		Silver.[b]	Copper.	Lead.	Zinc.	Total value.
			Placer.	Deep.					
		Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	748	2,688,706	$661,028	$15,068,196	7,304,353	8,122,004	67,990,012	120,315,775	$42,084,668
1918	588	2,314,890	526,202	12,225,516	7,063,554	6,277,332	65,960,760	89,133,901	34,160,172
Decrease, 1918	160	373,816	134,826	2,842,680	240,799	1,844,672	2,029,252	31,181,874	7,924,496

[a] A revised table showing the production of gold, silver, copper, lead, and zinc from the beginning of mining in Colorado to 1918 will be included in a professional paper, "The history and development of mining in Colorado, 1859–1918," now in preparation.

[b] Includes placer production.

GOLD.

The total production of gold in Colorado in 1918 was 616,864.36 fine ounces, valued at $12,751,718, a decrease of 144,036.86 fine ounces and of $2,977,506 in value, following a decrease of $3,424,597 in 1917 and of $3,261,123 in 1916.

The Cripple Creek district, with a decrease of $2,275,100, produced $8,119,747 in gold, the smallest output from this district since 1896, but representing 64 per cent of the State yield in 1918.

The San Juan region of Dolores, La Plata, Ouray, San Juan, and San Miguel counties, yielded $2,502,804, an increase for the region of $51,512, following a decrease of $589,983 in 1917, following a decrease of $813,246 in 1916, a decrease of $115,336 in 1915, and a decrease of $101,826 in 1914. Lake County yielded $843,239, a decrease of $331,980. There were decreases of $21,146 in Chaffee, $72,907 in Clear Creek, $115,703 in Gilpin, $54,182 in Park, $60,995 in San Juan, and $136,298 in Summit counties. There was an increase of $117,673 in San Miguel County.

Siliceous and dry ore, which constituted 76 per cent of all the ore sold or treated, yielded 92 per cent of all the gold produced. Nearly 3 per cent of gold came from lead ores, more than 4 per cent from placers, and nearly 1 per cent from lead-zinc ores.

The output of placer gold from 12 placers in 1918 was $526,202, a decrease of $134,826. Summit County, with 5 dredges and 1 sluice mine, produced 82 per cent of the placer yield, and 1 dredge and 1 sluice mine in Lake County produced 17 per cent. The remainder came from hydraulicking and sluicing in Gunnison and Moffat counties.

SILVER.

The yield of silver in Colorado in 1918 was 7,063,554 fine ounces, valued at $7,063,554, a decrease of 240,799 fine ounces in quantity but an increase of $1,044,767 in value, following a decrease of 352,191 fine ounces in 1917, an increase of 628,572 fine ounces in 1916, a decrease of 1,768,093 fine ounces in 1915, and a decrease of 529,190 fine ounces in 1914.

Custer County showed an increase for 1918 of 19,769 ounces; Eagle, 105,383 ounces; Lake, 106,121 ounces; Mineral, 279,442 ounces; and San Miguel, 57,206 ounces; and there were also increases in Gilpin, Hinsdale, Park, and Saguache counties. Boulder County showed a decrease of 137,644 ounces; Chaffee, 65,348 ounces; Clear Creek, 155,862 ounces; Dolores, 33,973 ounces; Gunnison, 27,392 ounces; Ouray, 66,738 ounces; Pitkin, 103,323 ounces; San Juan, 180,939 ounces; and Summit, 58,373 ounces; and there were also decreases in La Plata and Teller counties.

Siliceous and dry ores yielded 67 per cent of the total silver; lead ores, 21 per cent; lead-zinc ores, 8 per cent; copper ores, more than 2 per cent; and zinc ores, 1 per cent.

COPPER.

The output of copper in 1918 was 6,277,332 pounds, valued at $1,550,501, a decrease of 1,844,672 pounds in quantity and of $666,806 in value. Although copper is widespread in the ores of Colorado, there are strictly no producing copper mines in the State, and the output for each year is mainly a valuable by-product of other ores.

Lake County was the leading producer of copper, yielding 26 per cent of the copper output; San Juan was second, with 18 per cent; San Miguel was third, with 16 per cent; Dolores was fourth, with 10 per cent; and Gilpin, Eagle, Clear Creek, and Chaffee followed in order.

Siliceous and dry ores furnished 57 per cent of the copper output; copper ores 27 per cent; lead ores 10 per cent; copper-lead ores 2 per cent; and lead-zinc ores 4 per cent.

LEAD.

The production of lead (in terms of lead in lead bullion and in leaded-zinc oxide) in Colorado in 1918 was 65,960,760 pounds, valued at $4,683,214, a decrease of 2,029,252 pounds in quantity and of $1,163,927 in value.

Lake and Pitkin counties are the principal lead-producing districts in Colorado. In 1918 there were heavy decreases in Clear Creek, Dolores, Pitkin, and San Juan, and also decreases in Boulder, Chaffee, Gunnison, and Mineral counties. Lake County showed the greatest increase, and there were large increases in Eagle, Hinsdale, and Ouray counties.

In rank, Lake County was first, Pitkin was second, San Juan third, San Miguel fourth, Clear Creek fifth, and Eagle, Ouray, Chaffee, Mineral, Summit, Gilpin, Hinsdale, and Dolores followed in order. There was a decided increase in quantity of lead ores produced and of their lead content, but a heavy decrease of lead-zinc ores and of lead contained therein; there was also a decrease in quantity of dry ores and a corresponding decrease in lead content.

Lead ores furnished 50 per cent of the output of lead; dry and siliceous ores, 25 per cent; lead-zinc ores, 21 per cent; zinc ores, nearly 3 per cent; and copper and lead-copper ores nearly 1 per cent.

ZINC.

In 1918 the marketed zinc ores from Colorado contained 89,133,901 pounds of recoverable zinc, valued at $8,111,185, a decrease of 31,181,874 pounds in quantity and of $4,161,024 in value.

Lead-zinc ores furnished 73 per cent of the total yield of zinc; zinc ores, 25 per cent; and dry and siliceous ores, 2 per cent.

Lake County, with a decrease of 13,538,597 pounds, produced 46,715,736 pounds, representing 52 per cent of the zinc output of the State, as compared with 50 per cent in 1917, with 57 per cent in 1916, 69 per cent in 1915, and 81 per cent in 1914. Leadville shipments of zinc carbonate ore amounted to 21,292 tons, carrying 18.64 per cent of zinc; lead-zinc and zinc sulphide ores sold or treated in Leadville amounted to 125,281 tons carrying 24.90 per cent of zinc.

The production of zinc in Summit County was 15,696,264 pounds and in Eagle County 14,845,341 pounds. The largest decreases were in Clear Creek, Dolores, Eagle, Lake, and Summit counties. There were increases in Chaffee and San Juan counties.

Zinc and lead-zinc ore and concentrates as marketed at the mine or mine mill[a] *in Colorado in 1918.*

County and district.	Classification.	Quantity.	Estimated recoverable zinc.	Zinc content.	Average assay of zinc.
		Short tons.	*Pounds.*	*Pounds.*	*Per cent.*
Chaffee (ore and concentrates). Custer (ore), Gunnison (ore), Pitkin (ore).	Smelting ore and concentrates.	9,972	5,127,109	6,345,698	31.82
Lake	Concentrating and smelting zinc-lead sulphide ore and concentrates.	125,567	40,364,053	62,428,930	24.86
	Zinc carbonate ore	21,292	6,351,683	7,939,602	18.64
Clear Creek and Gilpin	Concentrates	2,881	1,840,945	2,299,923	39.92
Eagle and Summit	Concentrating and smelting ore and concentrates.	58,584	30,541,605	38,812,168	33.13
San Juan region: Dolores (ore), Ouray (concentrates), San Miguel (ore and concentrates), San Juan (concentrates).	Smelting ore and concentrates.	9,116	4,908,506	6,135,837	33.65
		227,412	89,133,901	123,962,158	27.25
SUMMARY.					
Lake	Ore and concentrates	146,859	46,715,736	70,368,532	23.96
All other counties	do	80,553	42,418,165	53,593,626	33.27
		227,412	89,133,901	123,962,158	......
Total carbonate ore	Crude ore	27,838	9,657,969	12,009,264	21.57
Total sulphide ore	Ore and concentrates	199,574	79,475,932	111,952,894	28.05

[a] Includes quantity of crude ore and contents as shipped to custom plants at Leadville, Pueblo, Canon City, and Denver, not the product of these mills, in order not to disclose individual milling operations.

OUTPUT OF ORE AND METAL CONTENT.

Ore and metals produced in Colorado in 1918.

Source of production.	Ore.		Gold.		Silver.	
	Short tons.	*Per cent.*	*Fine ounces.*	*Per cent.*	*Fine ounces.*	*Per cent.*
Dry ore	1,760,222	76.04	566,274.64	91.80	4,753,627	67.30
Copper ore	18,088	.78	1,968,68	.32	166,296	2.36
Lead ore	183,274	7.92	17,036.60	2.76	1,456,023	20.61
Lead-copper ore	1,760	.07	198.17	.03	35,260	.50
Zinc ore	60,350	2.61	1,098.26	.18	75,568	1.07
Zinc-lead ore	291,196	12.58	4,832.99	.78	570,130	8.07
Total deep mines	2,314,890	100.00	591,409.34	95.87	7,056,904	99.91
Total placers	....	....	25,455.02	4.13	6,650	.09
Total, deep and placers, 1918	2,314,890	100.00	616,864.36	100.00	7,063,554	100.00
Total, deep and placers, 1917	2,688,706	....	760,901.22	....	7,304,353	....
Decrease	373,816	....	144,036.86	....	240,799	....

Source of production.	Copper.		Lead.		Zinc.	
	Pounds.	*Per cent.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*
Dry ore	3,590,901	57.21	16,598,612	25.16	2,249,506	2.52
Copper ore	1,668,087	26.57	169,957	.26	....	....
Lead ore	600,038	9.56	33,155,889	50.27	....	....
Lead-copper ore	138,132	2.20	309,041	.47	....	....
Zinc ore	11,490	.18	1,723,508	2.61	22,166,061	24.87
Zinc-lead ore	268,684	4.28	14,003,753	21.23	64,718,334	72.61
Total deep mines	6,277,332	100.00	65,960,760	100.00	89,133,901	100.00
Total placer mines	....	....	....	....	....	....
Total, deep and placers, 1918	6,277,332	100.00	65,960,760	100.00	89,133,901	100.00
Total, deep and placers, 1917	8,122,004	....	67,990,012	....	120,315,775	....
Decrease	1,844,672	....	2,029,252	....	31,181,874	....

Placer output in Colorado in 1918.

County.	Sluice and hydraulic.		Dredges.		Total.	
	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.
	Fine ounces.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*
Gunnison	3.53	....	....	....	3.53	....
Lake	6.34	1	4,447.35	1,289	4,453.69	1,290
Moffat	147.06	7	....	....	147.06	7
Summit	1.79	....	20,848.95	5,353	20,850.74	5,353
Total, 1918	158.72	8	25,296.30	6,642	25,455.02	6,650
Total, 1917	755.53	129	31,221.71	8,173	31,977.24	8,302
Decrease	596.81	121	5,925.41	1,531	6,522.22	1,652

Content of dry and siliceous gold and silver ores sold or treated in Colorado in 1918.

County.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Boulder	8,832	2,380.82	26,322	2,198	26,743	....
Chaffee	28,022	3,755.85	37,555	68,284	977,881	1,391,473
Clear Creek	34,861	8,659.74	153,181	261,246	1,160,529	....
Custer	3,449	185.95	72,622	22,319	112,017	....
Dolores	62	16.21	1,865	798	962	....
Eagle	16,379	1,694.73	198,880	352,235	281,472	....
Fremont	95	1.80	268	3,770	1,113	....
Garfield	15	44.80	15	....	....	....
Gilpin	22,334	12,445.65	99,425	394,563	568,915	28,099
Gunnison	639	434.55	3,877	1,182	4,924	....
Hinsdale	610	48.50	3,636	665	4,347	....
Lake	154,893	28,755.97	1,633,572	1,101,745	2,791,678	....
La Plata	297	356.91	6,383	668	183	....
Mineral	26,225	423.89	601,135	3,490	733,561	....
Ouray	76,117	4,969.14	647,511	69,888	1,558,788	39,297
Park	1,255	18.51	9,581	1,656	57,626	....
Pitkin	26,383	....	222,508	8,972	1,261,711	....
Routt	148	30.57	2,198	....	....	....
Saguache	405	31.82	14,301	4,616	....	....
San Juan	34,081	5,136.23	85,343	331,899	1,181,739	....
San Miguel	373,077	102,745.27	802,848	949,260	5,624,659	790,637
Summit	15,717	1,344.70	79,846	11,947	249,764	....
Teller	936,326	392,792.76	50,665	....	....	....
Total, 1918	1,760,222	566,274.64	4,753,627	3,590,901	16,598,612	2,249,506
Total, 1917	1,996,590	692,605.92	4,867,628	3,630,445	18,673,295	3,098,598
Decrease	236,368	126,331.28	114,001	39,544	2,074,683	849,092

Content of copper ores sold or treated in Colorado in 1918.[a]

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Chaffee	2,933	11.11	2,550	217,359	....
Clear Creek	149	192.30	1,832	13,564	3,847
Custer	72	3.28	1,964	5,480	1,696
Dolores	6,660	117.40	45,093	613,959	11,766
Eagle	5	4.57	109	722	134
Fremont	140	13.20	371	18,607	....
Gilpin	478	516.50	5,755	51,401	2,225
Gunnison	830	53.73	1,202	41,604	....
Hinsdale	40	1.72	642	4,405	2,417
Jefferson	23	....	9	1,000	....
Lake	3,898	405.30	10,019	402,060	34,760
Ouray	95	20.58	1,574	8,670	641
Pitkin	10	.10	99	712	....
Saguache	936	83.49	70,309	84,798	42,454
San Juan	1,819	545.40	24,768	203,746	70,017
Total, 1918	18,088	1,968.68	166,296	1,668,087	169,957
Total, 1917	33,233	7,455.00	182,791	3,133,437	455,698
Decrease	15,145	5,486.32	16,495	1,465,350	285,741

[a] All smelting ore.

Content of lead-copper ores sold or treated in Colorado in 1918.[a]

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Boulder	53	13.50	2,240	5,471	5,293
Clear Creek	21	9.90	405	1,175	4,413
Custer	181	3.60	6,648	21,210	28,912
Hinsdale	65	4.20	1,490	5,796	21,862
Ouray	953	26.22	10,571	63,134	97,060
Park	33	1.62	1,160	2,894	10,456
San Juan	181	108.03	4,075	18,869	40,722
San Miguel	273	31.10	8,671	19,583	100,323
Total, 1918	1,760	198.17	35,260	138,132	309,041
Total, 1917	2,976	1,239.89	133,128	204,563	428,115
Decrease	1,216	1,041.72	97,868	66,431	119,074

[a] All smelting ore.

Content of lead ores sold or treated in Colorado in 1918.

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Boulder	1,502	134.00	128,169	10,218	230,274
Chaffee	5,905	1,674.16	41,082	38,187	886,166
Clear Creek	4,699	2,025.38	112,075	61,686	1,310,817
Custer	592	15.57	26,110	2,283	128,845
Dolores	551	18.09	7,048	8,255	204,766
Eagle	197	3.30	1,149	....	49,712
Gilpin	842	649.80	19,749	10,080	203,832
Gunnison	83	9.74	2,255	247	21,060
Hinsdale	4,507	247.79	16,477	7,442	739,346
Lake	50,190	5,044.93	339,219	111,239	12,336,187
La Plata	3	....	32	....	2,817
Mineral	2,147	250.60	39,824	....	256,059
Ouray	2,488	191.39	141,703	11,925	931,426
Park	1,016	3,036.01	7,539	8,154	165,791
Pitkin	71,720	....	336,025	....	10,385,787
Routt	13	3.20	466	....	6,591
Saguache	375	8.19	4,900	7,452	65,799
San Juan	34,333	3,322.72	194,458	302,640	4,538,020
San Miguel	767	147.42	24,732	23,971	312,703
Summit	1,294	254.31	13,011	1,259	379,891
Total, 1918	183,274	17,036.60	1,456,023	600,038	33,155,889
Total, 1917	103,081	19,220.68	1,167,167	784,684	20,688,207
Increase or decrease	+80,193	−2,184.08	+288,856	−184,646	+12,467,682

Content of zinc ores sold or treated in Colorado in 1918.[a]

County.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Chaffee	2,661	....	....	....	....	1,192,554
Eagle	4,283	....	2,565	....	77,000	746,025
Gunnison	3,841	....	....	....	....	2,072,615
Lake	47,405	1,086.26	72,373	11,490	1,639,308	16,601,986
Pitkin	103	....	....	....	....	46,067
Summit	2,057	12.00	630	....	7,200	1,506,814
Total, 1918	60,350	1,098,26	75,568	11,490	1,723,508	22,166,061
Total, 1917	140,455	522.63	19,525	20,496	1,000,413	47,582,031
Increase or decrease	−80,105	+575.63	+56,043	−9,006	+723,095	−25,415,970

[a] Nearly all smelting ore.

Content of lead-zinc ores sold or treated in Colorado in 1918.[a]

County.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Chaffee	77				21,714	34,742
Clear Creek	18,078	291.03	103,395	5,576	1,389,746	1,812,846
Custer	32	1.60	1,112		9,600	13,516
Dolores	1,999		243		299,900	661,253
Eagle	68,811	37.69	38,703	84	2,518,781	14,099,316
Gunnison	951		5,546		274,776	276,923
Lake	99,454	1,045.54	233,648		5,667,982	30,113,750
Pitkin	197				19,094	99,219
San Juan	62,463	3,320.53	168,678	263,024	3,655,277	3,410,308
San Miguel	17	.50	319		6,400	7,011
Summit	39,117	136.10	18,486		140,483	14,189,450
Total, 1918	291,196	4,832.99	570,130	268,684	14,003,753	64,718,334
Total, 1917	412,371	7,879.86	925,812	348,379	26,744,284	69,635,146
Decrease	121,175	3,046.87	355,682	79,695	12,740,531	4,916,812

[a] Nearly all concentrating ore.

REDUCTION MILLS.

Mineral Resources for 1912, Part I, pages 650–664, contains a complete list of reduction mills in Colorado in 1912, with description of equipment and process. Changes of equipment have been noted in the volumes of Mineral Resources for each year since 1912 in the text relating to the several counties, and reference should be made to the report for 1912 and those following for complete information in regard to any particular mill.

Gold and silver produced at mills in Colorado, 1918.

County.	Ore to gold and silver mills.	Gold in bullion.	Silver in bullion.	Ore to concentrating mills.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
Boulder	410	183.50	90	6,795
Chaffee				27,436
Clear Creek	1,396	281.04	155	50,899
Custer	75		690	
Eagle				68,811
Gilpin	6,525	852.06	308	14,786
Gunnison	280	85.59	64	
Hinsdale				4,270
Lake		780.74	260	99,454
Mineral				1,221
Ouray	36,790	454.13	531	37,418
Park	10	4.31	1	960
Pitkin				57,213
Routt		3.98	3	136
San Juan		1,651.83	783	128,775
San Miguel	360,276	70,428.81	294,267	12,769
Summit	4,200	684.43	366	44,319
Teller	935,489	379,865.76	47,762	
Total, 1918	1,345,451	455,276.18	345,280	555,262
Total, 1917	1,487,304	553,553.59	400,109	699,094
Decrease, 1918	141,853	98,277.41	54,829	143,832
Average content per ton		0.3384	0.2566	

Mine production of metals from Colorado concentrates in 1918.

By counties.

	Concentrates.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Boulder	245	822.80	2,410	1,364		
Chaffee	3,628	3,660.90	30,522	63,283	953,304	1,431,165
Clear Creek	9,846	7,841.20	245,306	243,434	2,720,187	1,812,846
Eagle	31,894	37.69	38,703	84	2,518,781	14,099,316
Gilpin	4,782	10,408.79	89,348	368,046	531,830	28,099
Gunnison	28	35.11	888	106	2,249	
Hinsdale	798	100.03	11,820	4,676	481,482	
Lake	73,879	1,045.54	233,648		5,667,982	30,113,750
Mineral	111	29.90	586		64,934	
Ouray	7,018	3,771.94	572,719	57,306	1,547,311	39,297
Park	101	.10	6,058	1,656	42,119	
Pitkin	19,071		210,651		4,845,398	
Routt	17	26.49	1,389			
San Juan	17,936	9,305.64	345,643	822,224	8,673,629	3,410,308
San Miguel	27,912	32,306.16	508,136	948,944	5,623,388	790,637
Summit	20,626	428.11	30,590	3,441	337,494	14,189,450
Teller	8,400	11,575.00	2,220			
Total, 1918	226,292	81,395.40	2,330,637	2,514,564	34,010,088	65,914,868
Total, 1917	280,563	87,650.41	2,600,743	2,686,546	41,122,473	76,381,990
Decrease, 1918	54,271	6,255.01	270,106	171,982	7,112,385	10,467,122

By kinds of concentrates.

Dry and siliceous	35,233	26,402.64	510,664	220,600	689,654	
Copper	1,265	1,126.40	21,227	235,851	54,348	
Lead	83,695	42,624.42	1,465,403	847,856	26,935,533	
Copper-lead	11,951	8,984.56	178,002	949,308	2,445,570	
Total to copper and lead plants	132,144	79,138.02	2,175,296	2,253,615	30,125,105	
Zinc	69,679	869.33	80,028	99,378	1,248,581	51,373,514
Lead-zinc	24,469	1,388.05	75,313	161,571	2,636,402	14,541,354
Total to zinc and lead-zinc plants	94,148	[a] 2,257.38	[a] 155,341	[a] 260,949	[b] 3,884,983	[c] 65,914,868

Average content.

		Fine ounces per ton.	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Dry and siliceous		0.75	14.49	0.31	0.98	
Copper		.89	16.78	9.32	2.15	
Lead		.51	17.51	.51	16.09	
Copper-lead		.75	14.89	3.97	10.23	
Total average		.60	16.46	.85	11.40	
Zinc		.01	1.15	.07	.90	[d] 45.75
Lead-zinc		.57	3.08	.33	5.39	[d] 37.14
Total average		.02	1.65	.14	2.06	[d] 43.52

[a] Recovered in zinc residues.
[b] Lead recovered in zinc residues and leaded zinc oxide.
[c] Zinc recovered as metal and zinc in zinc oxide.
[d] Assay of content; no reduction for loss in smelting.

Mine production of metals from Colorado crude ore shipped to smelters in 1918.

By counties.

	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Boulder	3,182	1,522.02	154,231	16,523	262,310	....
Chaffee	12,162	1,780.22	50,665	260,547	932,457	1,187,604
Clear Creek	5,513	3,056.11	125,427	99,813	1,149,165	....
Custer	4,251	210.00	107,766	51,292	281,070	13,516
Dolores	9,272	151.70	54,249	618,012	517,394	661,253
Eagle	20,864	1,702.60	202,703	352,957	408,318	746,025
Fremont	235	15.09	639	22,377	1,113	....
Garfield	15	44.89	15	....	....	....
Gilpin	2,343	2,351.10	35,273	87,998	243,142	....
Gunnison	6,064	377.32	11,928	42,927	298,511	2,349,538
Hinsdale	952	202.27	10,425	13,632	286,490	....
Jefferson	23	....	9	1,000	....	....
Lake	256,386	34,511.72	2,054,923	1,626,534	16,801,933	16,601,986
La Plata	300	356.91	6,415	668	3,000	....
Mineral	27,151	644.59	640,373	3,490	924,686	....
Ouray	5,445	981.26	228,109	95,811	1,040,604	....
Park	1,834	3,051.73	12,221	11,048	191,754	....
Pitkin	41,200	.10	348,071	9,684	6,821,194	145,286
Routt	25	3.30	1,272	....	6,591	....
Saguache	1,716	123.50	89,510	96,866	108,253	....
San Juan	4,152	1,475.44	130,896	297,954	812,146	....
San Miguel	1,089	189.32	34,167	43,870	420,697	7,011
Summit	9,666	634.57	81,017	9,765	439,844	1,506,814
Teller	837	1,352.00	683	....	....	....
Total, 1918	414,177	54,737.76	4,380,987	3,762,768	31,950,672	23,219,033
Total, 1917	502,308	87,719.98	4,295,199	5,435,458	26,867,539	43,933,785
Increase or decrease, 1918	−88,131	−32,982.22	+85,788	−1,672,690	+5,083,133	−20,714,752

By kinds of ore.

	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
Dry and siliceous	228,658	37,531.98	2,896,321	1,583,116	4,751,936	....
Lead	102,184	13,938.97	1,200,322	361,943	24,364,746	....
Copper	18,088	1,968.28	166,296	1,668,087	169,957	....
Copper-lead	1,760	198.17	35,260	138,132	309,041	....
Total to lead and copper plants	350,690	53,637.40	4,298,199	3,751,278	29,595,680	....
Zinc	60,214	1,098.26	75,568	11,490	1,723,508	22,126,369
Lead-zinc	3,273	2.10	7,220	....	631,484	1,092,664
Total to zinc smelters and zinc oxide plants	63,487	[a] 1,100.36	[a] 82,788	[a] 11,490	[b] 2,354,992	[c] 23,219,033
	414,177	54,737.76	4,380,987	3,762,768	31,950,672	23,219,033

Average content.

	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
		Fine ounces per ton.	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Dry and siliceous	....	0.16	12.67	0.35	1.04	....
Lead	....	.14	11.75	.18	11.92	....
Copper	....	.11	9.19	4.61	.47	....
Copper-lead	....	.11	20.03	3.92	8.78	....
Total average	....	.16	12.26	.53	4.22	....
Zinc	....	.02	1.25	.01	1.43	[d] 22.88
Lead-zinc	....	....	2.21	....	9.65	[d] 20.87
Total average	....	....	1.30	....	1.85	[d] 22.78

[a] Recovered in zinc residues.

[b] Lead recovered in zinc residues and leaded zinc oxide.

[c] Zinc recovered as metal and zinc in zinc oxide.

[d] Assay of content; no deduction for loss in smelting.

In 1918 Colorado mills consumed 6,050 pounds of quicksilver, or 1 pound for every 52 tons of ore, or 1 pound for every 4.17 ounces of gold and 2.90 ounces of silver; also 779,741 pounds of sodium cyanide were used at the ratio of 0.67 pound per ton of ore and tailings treated, and for every pound used there were recovered 0.55 ounce of gold and 0.42 ounce of silver.

Ore, concentrates, and tailings sent to amalgamation and cyanidation mills and gold and silver contained in bullion and precipitates in Colorado in 1918.

Process.	Quantity.	Gold in bullion.	Silver in bullion.	Quicksilver used.	Sodium cyanide used.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Amalgamation	[a] 314,487	25,233.61	17,554	6,050	....
Cyanidation	[b] 1,161,161	430,042.57	327,726	....	779,741
	....	455,276.18	345,280	....	....

[a] Represents original crude ore; amalgamation commonly followed by concentration or cyanidation or both. At one plant amalgamation follows concentration.

[b] Represents original crude ore, concentrates, and tailings or slimes of ore first treated by amalgamation and concentration. In one large custom mill, where ore is crushed in cyanide solution and the greater part of product is in form of cyanide precipitates, a very considerable quantity of the gold is recovered on blanket tables by use of mercury, and the amalgamation bullion is credited to cyanidation.

MINING INDUSTRY.

The mine output of gold, silver, copper, lead, and zinc in Colorado in 1918 was $12,751,718 in gold, 7,063,554 ounces of silver, 6,277,332 pounds of copper, 65,960,760 pounds of lead, and 89,133,901 pounds of zinc, with a total value of $34,160,172, as compared with $42,084,668 in 1917, a decrease for 1918 of $7,924,496, or 19 per cent. There were decreases in quantities of all five metals, but the increased average value for silver resulted in an increase for 1918 in gross value of silver of $1,044,767. Gold decreased $2,977,506 in value, copper $666,806, lead $1,163,927, and zinc $4,161,024.

The decrease in gold showed in both bullion products and in ore and concentrates marketed directly to lead plants, but there was an increase of silver and lead contents in ore marketed direct to smelters, the decrease in silver and lead being due to a decrease in lead concentrates from lead-zinc ores.

The five lead-copper plants at Salida, Globe, Pueblo, Durango, and Leadville were operated at part capacity, with a considerably decreased quantity of ore and concentrates from Colorado mines treated, the concentrates amounting to 132,144 tons, as compared with 163,171 tons in 1917, and the straight smelting ore amounting to 350,690 tons, as compared with 377,753 tons in 1917. The quantity of ore from other States and the quantity of zinc residues from Kansas-Oklahoma zinc retort plants was also less in 1918 than in 1917. The United States Zinc Co.'s magnetic-separation wet-concentration mill and zinc retort smelter, at Pueblo, treating lead-zinc sulphide ores from the Western States, was not as actively operated as in 1917. The River Smelting & Refining Co.'s plant at Florence continued to treat low-grade zinc-lead-copper ores from Colorado and other Western States. The Western Zinc Concentrating Co.'s zinc-oxide plant at Leadville was steadily operated on Leadville zinc-carbonate ores, and the new Ohio zinc-oxide plant at Canon City, which was started in June, 1918, was operated on Colorado zinc-carbonate ores. The Empire Zinc Co.'s magnetic separation mill at Canon City was operated steadily on Red Cliff and Leadville zinc and zinc-lead sulphide ores, but the Western Chemical Co.'s magnetic-separation wet-concentration mill at Denver, treating similar ores, was idle part of the year. Copper ore, lead bullion, lead-copper matte, and cyanide precipitates were shipped from Colorado to the smelter at Omaha, and some copper and lead ores were shipped from Rico to plants in Utah. The quantity of zinc ores sent to zinc-oxide and zinc retort plants in Kansas, Oklahoma, and Eastern States decreased heavily. Much silver-bearing pyrite was used for the manufacture of sulphuric acid at Denver and Louviers, and some pyrite went to the East and the South. Considerable manganese ore, chiefly from Leadville, was shipped to Pueblo and to the Eastern and Southern States.

Smelting plants in Colorado in 1918.

City.	Plant.	Owner.	Class of ore.	Product.	Total furnaces.[a]
Denver	Globe	American Smelting & Refining Co.	Lead base[b]	Lead bullion and copper matte.	7.
Pueblo	Pueblo	do	do	do	7.
Leadville	Arkansas Valley	do	do	do	10.
Durango	Durango	do	do	do	4.
Salida	Salida[c]	Ohio & Colorado Smelting & Refining Co.	do	do	4.
Pueblo	United States Zinc Co.	American Smelting & Refining Co.	Zinc, lead, copper, gold, silver.	Zinc and zinc dust.	1,944 retorts.
Ouray	Crawford[d]	Ouray Smelting & Refining Co.	Pyritic copper	Copper matte	2.
Florence	Florence (Old Rocky Mountain).[e]	River Smelting & Refining Co.	Zinc, lead, copper gold, silver.	Zinc oxide, lead sulphate, matte.	Undergoing changes.
Leadville		Western Zinc Concentrating Co.	Zinc carbonate	Zinc oxide	14 fire boxes.
Vulcan	Vulcan[d]	Vulcan Mines & Smelting Co.	Copper	Copper matte	1.
Canon City.	Ohio[f]	Ohio Zinc Co.	Zinc carbonate	Zinc oxide	Wetherill furnaces.

[a] Not all used.

[b] Copper ores and copper in other ores are handled by occasionally turning a lead furnace into a copper furnace.

[c] Weeks, F. D., The Salida smelter: Am. Inst. Min. Eng. Bull. 104, pp. 1691-1695, 1915.

[d] Idle.

[e] Intermediate plant of River Smelting & Refining Co., Keokuk, Iowa, for production of electrolytic zinc.

[f] Began smelting June, 1918.

Cripple Creek produced $8,119,747 in 1918, as compared with $10,394,847 in 1917, a decrease of $2,275,100. The adverse conditions affecting mining in the Cripple Creek district during 1917 continued in an accentuated form throughout 1918. Almost without exception, every improvement devised to reduce costs and every economy instituted during the year was immediately offset by some increase in the cost of labor or of some chemical or commodity entering into the extraction of gold. The production of high-grade ores in the Cripple Creek district fell off to such an extent that it was impossible to operate at a profit both of the reduction mills at Colorado Springs. As the Portland mill was the smaller of the two, it was decided to discontinue its operation, and to have the Portland high-grade ores treated at the Golden Cycle mill. The Portland Co.'s Victor cyanide-concentration mill was closed on July 30, 1918, owing to the impossibility of obtaining labor sufficient to supply the quantity of low-grade ore necessary for economical operation of both this mill and the Portland Independence mill.

The Portland Independence cyanide-concentration mill treated a considerable quantity of low-grade ore during the year, but, although the percentage of extraction was good, the profits realized were disappointing, largely owing to war conditions. The Roosevelt drainage tunnel was connected in 1918 with Portland No. 2 shaft at a depth of 2,131 feet from the surface. The main drainage tunnel, work on which was commenced 11 years ago, is 24,255 feet from its portal to its heading, which is located about the middle of the northerly portion of the Portland Co.'s property. The tunnel does not appear to assist in the drainage of the Vindicator Co.'s mines. Early in 1918 development work was discontinued on the twentieth and bottom level of the Golden Cycle shaft of the Vindicator Co. On this level a total of 4,240 feet had been done, but no ore of commercial grade was exposed. The vein systems were found in place, the fracturing was strong and well defined, and the general physical appearance was favorable to ore deposition, but the content of gold was too low to meet the cost of working. The ore reserves of the Vindicator Co. were greatly depleted during the year, because, owing to high costs, it was possible to do only a moderate amount of development work and the work that was done did not open up an appreciable quantity of ore. Considerable diamond drilling was done on the properties of the Cresson Co. and the United Gold Mines Co.

Lake County, chiefly Leadville but including also the Lackawanna Gulch, Sugar Loaf, St. Kevin, and Wortman lode districts and the Arkansas River dredge district, produced $843,239 in gold, 2,290,121 ounces of silver, 1,626,534 pounds of copper, 22,469,915 pounds of lead, and 46,715,736 pounds of zinc, with a total gross value of $9,381,610 in 1918, compared with $1,175,219 in gold, 2,184,000 ounces of silver, 2,182,623 pounds of copper, 18,301,802 pounds of lead, and 60,254,333 pounds of zinc, with a total gross value of $11,290,588 in 1917. Manganese iron ore, maganese silver fluxing, lead carbonate, and zinc carbonate ores in large quantities were shipped from the Downtown district, which was unwatered in 1916. Considerable sulphide ores were shipped from the Fryer Hill district (also unwatered in 1916) until June, when the entire operation of this area under the management of the U. S. Smelting Co. was abandoned. Lessees continued work in this area, however, throughout the remainder of the year. The year saw the close of the Moyer-Tucson mines of the Iron Silver Co., which had, however, purchased additional property. The cessation of pumping at the Moyer mine added to the water at the Cord winze of the Yak Co., so that with increased costs of mining and other difficulties this property did no produce to its usual standard.

In the San Juan region the situation as to labor, mining costs, and the epidemic of influenza was particularly arduous, but despite these difficulties San Juan County's production decreased only $60,995 in gold, 180,939 ounces of silver, 545,745 pounds of copper, and 1,029,760 pounds of lead, and the county produced 3,410,308 pounds of zinc, a small increase, as compared with 1917.

The output from mines in San Miguel County, not including the ore treated by San Miguel mills from Ouray County, showed an increase for gold, silver, and copper, but a decrease for lead and zinc. Ouray County mines, including the ore milled in San Miguel County, showed an increase for gold and lead, but small decreases for silver and copper and an appreciable decrease for zinc. The Camp Bird Co. continued development work, but no ore was treated. The Red Mountain district did not equal its 1917 production, but the Sneffels district and the Uncompahgre district maintained about the same output as in 1917. La Plata County mines were practically idle, the production being only nominal. Dolores County (Rico) showed a small increase for copper but appreciable decreases for gold, silver, lead, and zinc. Hinsdale County's production was the largest since 1912, owing to the unwatering and reopening of the Ute and Ulay mines, which, however, closed again in the fall. Mineral County (Creede) produced 640,959 ounces of silver, an increase of 77 per cent. Saguache County mines yielded 89,510 ounces of silver, an increase of 13,494 ounces, but there were decreases for gold, copper, and lead.

Summit County's zinc production fell from 19,868,814 pounds of recoverable zinc in 1917 to 15,696,264 pounds, placer gold fell from $540,951 to $431,023, and lode gold fell from $62,486 to $36,116. The silver production decreased from 175,699 ounces to 117,326 ounces. Eagle County mines were active under the management of the Empire Zinc Co.

Boulder County's yield of gold fell from $66,841 in 1917 to $52,265 in 1918 and of silver from 294,375 ounces to 156,731 ounces. Clear Creek County's gold decreased $72,907, silver 155,862 ounces, lead 967,265 pounds, and zinc 1,340,184 pounds. Despite the apparent idleness of most of the mines and the almost complete idleness of all the mills in Gilpin County, the gross value of the yield was 80 per cent of the gross value in 1917. Much of the ore was mined through the Argo tunnel. Early in the year the long established Chamberlain sampling plants at Black Hawk and Georgetown were closed and dismantled, and in October the Idaho Springs plant was closed and dismantled, but another company remodeled one of the idle sampling works at Idaho Springs and began receiving ore in November.

Chaffee County's production showed decreases for all metals except zinc, for which there was an increase of 20 per cent. Pitkin County (Aspen) produced 558,722 ounces of silver in 1918, as compared with 662,045 ounces in 1917, and 11,666,592 pounds of lead in 1918, as compared with 14,352,523 pounds in 1917.

Mine production of gold, silver, copper, lead, and zinc in Colorado in 1918.

County.	Producing mines.	Ore sold or treated.	Gold.		Silver.	
			Quantity.	Value.	Quantity.	Value.
		Short tons.	*Fine ounces.*		*Fine ounces.*	
Boulder	27	10,387	2,528.32	$52,265	156,731	$156,731
Chaffee	21	39,598	5,441.12	112,478	81,187	81,187
Clear Creek	59	57,808	11,178.35	231,077	370,888	370,888
Custer	12	4,326	210.00	4,341	108,456	108,456
Dolores	9	9,272	151.70	3,136	54,249	54,249
Eagle	19	89,675	1,740.29	35,975	241,406	241,406
Fremont	3	235	15.09	312	639	639
Garfield	1	15	44.89	928	15	15
Gilpin	51	23,654	13,611.95	281,384	124,929	124,929
Gunnison	14	6,344	501.55	10,368	12,880	12,880
Hinsdale	18	5,222	302.30	6,249	22,245	22,245
Jefferson	1	23	....	....	9	9
Lake	92	355,840	40,791.69	843,239	2,290,121	2,290,121
La Plata	14	300	356.91	7,378	6,415	6,415
Mineral	11	28,372	674.49	13,943	640,959	640,959
Moffat	2	....	147.06	3,040	7	7
Ouray	38	79,653	5,207.33	107,645	801,359	801,359
Park	11	2,304	3,056.14	63,176	18,280	18,280
Pitkin	15	98,413	.10	2	558,722	558,722
Routt	3	161	33.77	698	2,664	2,664
Saguache	10	1,716	123.50	2,553	89,510	89,510
San Juan	37	132,927	12,432.91	257,011	477,322	477,322
San Miguel	27	374,134	102,924.29	2,127,634	836,570	836,570
Summit	36	58,185	22,597.85	467,139	117,326	117,326
Teller	57	936,326	392,792.76	8,119,747	50,665	50,665
Total, 1918	588	2,314,890	616,864.36	12,751,718	7,063,554	7,063,554
Total, 1917	748	2,688,706	760,901.22	15,729,224	7,304,353	6,018,787
Increase or decrease	−160	−373,816	−144,036.86	−2,977,506	−240,799	+1,044,767

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Boulder	17,887	$4,418	262,310	$18,624	....	....	$232,038
Chaffee	323,830	79,986	1,885,761	133,889	2,618,769	$238,308	645,848
Clear Creek	343,247	84,782	3,869,352	274,724	1,812,846	164,969	1,126,440
Custer	51,292	12,669	281,070	19,956	13,516	1,230	146,652
Dolores	618,012	152,649	517,394	36,735	661,253	60,174	306,943
Eagle	353,041	87,201	2,927,099	207,824	14,845,341	1,350,926	1,923,332
Fremont	22,377	5,527	1,113	79	....	....	6,557
Garfield	....	....	....	....	....	....	943
Gilpin	456,044	112,643	774,972	55,023	28,099	2,557	576,536
Gunnison	43,033	10,629	300,760	21,354	2,349,538	213,808	269,039
Hinsdale	18,308	4,522	767,972	54,526	....	....	87,542
Jefferson	1,000	247	....	....	....	....	256
Lake	1,626,534	401,754	22,469,915	1,595,364	46,715,736	4,251,132	9,381,610
La Plata	668	165	3,000	213	....	....	14,171
Mineral	3,490	862	989,620	70,263	....	....	726,027
Moffat	....	....	....	....	....	....	3,047
Ouray	153,117	37,820	2,587,915	183,742	39,297	3,576	1,134,142
Park	12,704	3,138	233,873	16,605	....	....	101,199
Pitkin	9,684	2,392	11,666,592	828,328	145,286	13,221	1,402,665
Routt	....	....	6,591	468	....	....	3,830
Saguache	96,866	23,926	108,253	7,686	....	....	123,675
San Juan	1,120,178	276,684	9,485,775	673,490	3,410,308	310,338	1,994,845
San Miguel	992,814	245,225	6,044,085	429,130	797,648	72,586	3,711,145
Summit	13,206	3,262	777,338	55,191	15,696,264	1,428,360	2,071,278
Teller	....	....	....	....	....	....	8,170,412
Total, 1918	6,277,332	1,550,501	65,960,760	4,683,214	89,133,901	8,111,185	34,160,172
Total, 1917	8,122,004	2,217,307	67,990,012	5,847,141	120,315,775	12,272,209	42,084,668
Increase or decrease	−1,844,672	−666,806	−2,029,252	−1,163,927	−31,181,874	−4,161,024	−7,924,496

REVIEW BY COUNTIES.

BACA COUNTY.

No shipments were made in 1918 from the copper deposits in the Carrizo district, in the southwest corner of Baca County.

BOULDER COUNTY.

Mine production in Boulder County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	60	16,835	$66,841	294,375	29,513	575,582	$366,963
1918	27	10,387	52,265	156,731	17,887	262,310	232,038
Decrease, 1918.	33	6,448	14,576	137,644	11,626	313,272	134,925

Central district.—The production of the Central district (near Jamestown) was 499 tons of ore, carrying $4,029 in gold, 2,333 ounces of silver, 5,470 pounds of copper, and 5,296 pounds of lead, with a total value of $8,089, as compared with $36,946 in 1917. The only production of importance was from the Alice, Golden age, and Wano mines, where mining for fluorspar opened occasional pockets of gold ore and lead-copper-silver ore, some of which was shipped direct to smelters and some was concentrated.

Gold Hill district.—The production of the Gold Hill district was 6,967 tons of ore, carrying $23,994 in gold, 4,114 ounces of silver, 1,429 pounds of copper, and 1,000 pounds of lead, and having a total value of $28,532, as compared with $26,425 in 1917. The most important operation in the district was that of the 50-ton Slide table-concentration and oil-flotation mill on dump ores from the Slide mine. This mine, opened by a 1,000-foot vertical shaft, and 5,000 feet of drifts, was cleaned out and retimbered during 1918. Other producing mines were the Big Horn, Boulder Valley, Myrtle, Scotia, and Victoria. The Victoria mine is opened by a 470-foot shaft and 1,000 feet of drifts.

Grand Island district (Cardinal, Caribou, and Eldora).—This district in 1918 produced 1,250 tons of ore, carrying $9,433 in gold, 22,029 ounces of silver, 765 pounds of copper, and 25,634 pounds of lead, and having a total value of $33,471, as compared with $35,325 in 1917. The mines of this district include the mines in the vicinity of Caribou and Eldora. Nearly all the production was from Caribou. The principal producing mines were the Potosi, Monitor, and Caribou, from which silver ore was shipped direct to smelters. Small lots of smelting silver ore were shipped from the Belcher, Comstock, Up-To-Date, and Wigwam mines. From Eldora one small lot of gold ore was shipped from the Huron mine.

Magnolia district.—No mines were operated in the Magnolia district in 1918.

Sugar Loaf district.—The production of the Sugar Loaf district in 1918 was 946 tons, carrying $11,723 in gold, 60,219 ounces of silver, 10,117 pounds of copper, and 75,915 pounds of lead, and having a total value of $79,831, as compared with $87,770 in 1917. The principal producing mines were the Yellow Pine, from which lead-silver ore was shipped to smelters by lessees; and the Logan mine, from which gold smelting ore was shipped and considerable gold bullion in small lots from high-grade pockets. Several lots of tungsten ore were also shipped from the Logan. Other properties in the district produced small lots of gold specimens and gold smelting ore.

Ward district.—The Ward district in 1918 continued to be the principal producing district in the county, with a yield of 725 tons of smelting ore, carrying $3,086 in gold, 68,036 ounces of silver, 106 pounds of copper, and 154,465 pounds of lead, and having a total gross value of $82,115, as compared with $178,569 in 1917. The principal producing mine was the White Raven, from which lead silver ore was shipped. Other producing mines were the Celestial, Grand View, Moltke, and Wardner.

CHAFFEE COUNTY.

Mine production in Chaffee County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	29	55,652	[a] $133,624	[a] 146,535	807,883	2,150,523	2,181,932	$882,423
1918	21	39,598	112,478	81,187	323,830	1,885,761	2,618,769	645,848
Increase or decrease, 1918	− 8	− 16,054	− 21,146	− 65,348	−484,053	−264,762	+436,837	−236,575

[a] Includes placer production.

Chalk Creek district.—The Mary Murphy mine in this district continued to be the most important in the county, but with a decreased output, as predicted in the 1917 report of the general manager. Other producing mines were the Allie Belle, Flora Bell, and Queen of the Lake. The district produced 29,648 tons of mixed sulphide milling and smelting ore in 1918, as compared with 36,694 tons in 1917.

Cleora district.—No production was made in this district in 1918.

Cottonwood and South Cottonwood (Buena Vista) district.—No shipments were made from this district in 1918.

Free Gold district (Buena Vista).—Development work was continued at the Marion mine.

Granite district.—A car of gold ore was shipped from the Yankee Blade mine.

La Plata (Winfield) district.—A small lot of lead-silver ore was shipped from the Banner mine.

Monarch (Garfield) district.—From 10 mines 6,817 tons of various classes of ore was shipped, carrying $2,609 in gold, 21,672 ounces of silver, 32,004 pounds of copper, 776,085 pounds of lead, and 1,187,064 pounds of zinc, and having a total gross value of $195,360, as compared with $299,389 in 1917. The two principal producing mines were the Eclipse, from which was shipped considerable zinc oxidized ore, and the Madonna, from which was shipped considerable quantities of lead oxidized and zinc oxidized ores. Other mines of importance were the Black Hawk group, from which silver ore was shipped; the Hawkeye, from which lead-silver oxidized ore was shipped; the Jewell group, from which lead-silver oxidized ore was shipped; and the Lilly (Taylor Mountain Syndicate), from which lead-silver oxidized ore was shipped. Other producing mines were the Major, Rainbow, and Wilson.

Riverside district (Buena Vista).—Two cars of gold-silver sulphide ore, carrying also some copper and lead, were shipped from the Mount Harvard mine.

Turret district (including Sedalia).—From the Sedalia mine, a large quantity of mixed oxidized and sulphide copper-silver ore was shipped direct to smelters, and several cars of zinc sulphide ore were shipped to the Empire Zinc Co.'s concentration mill at Canon City. A small lot of gold ore was shipped from the M. & W. mine at Turret, and a car of copper-silver ore from the Independence mine at Turret.

CLEAR CREEK COUNTY.[1]

Mine production in Clear Creek County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	80	84,449	[a]$303,984	[1]526,750	570,091	4,836,617	3,153,030	$1,631,219
1918	59	57,808	231,077	370,888	343,247	3,869,352	1,812,846	1,126,440
Decrease, 1918	21	26,641	72,907	155,862	226,844	967,265	1,340,184	504,779

[a] Includes small placer production.

Alice (Yankee) district.—Small lots of gold ore from the Gold Anchor and from the Reynolds mine were treated in a small amalgamating mill in the Alice district.

Argentine district.—The Argentine district in 1918 produced from 3 mines only 199 tons of ore carrying $1,244 in gold, 3,007 ounces of silver, 6,530 pounds of copper, and 79,141 pounds of lead, and having a total value of $11,483 in 1918, as compared with $99,036 in 1917. Nearly all the ore was shipped direct to smelters from the Kittie Owsley, Santiago, and Paymaster mines.

Empire (Upper Union) district.—The Empire district in 1918 produced only 187 tons of ore, carrying $1,356 in gold, 8,236 ounces of silver, 303 pounds of copper, and 33,958 pounds of lead, and having a total value of $12,078, as compared with $18,242 in 1917. Several cars of lead-silver ore were shipped to smelters from the Bellevue-Hudson mine, and several cars in all from various other properties were shipped to the Argo concentration mill at Idaho Springs.

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[1] For discussion of geology see Spurr, J. E., and Garrey, G. H., Preliminary report on the ore deposits of the Georgetown mining district, Colo.: U. S. Geol. Survey Bull. 285, pp. 35-40, 1906; Economic geology of the Georgetown quadrangle (together with the Empire district), Colo., with general geology by S. H. Ball: U. S. Geol. Survey Prof. Paper 63, 422 pp., 1908; Bastin, E. S., and Hill, J. M., Economic geology of Gilpin County and adjacent parts of Clear Creek and Boulder counties, Colo.: U. S. Geol. Survey Prof. Paper 94, 1917.

Considerable development and mill construction work was done at the properties of the Golden Empire Co.

Geneva Creek (Collier Mountain) district.—Reopening of old properties was in progress in this district, reaching from Grant (Park County) north, via Hall Valley.

Griffith (Georgetown, Silver Plume) district.—The Georgetown-Silver Plume district in 1918 produced from 10 mines 20,249 tons of ore, yielding $10,837 in gold, 121,147 ounces of silver, 8,972 pounds of copper, 1,621,718 pounds of lead, and 1,812,846 pounds of zinc, and having a total value of $414,311, as compared with $699,039 in 1917.

The Capital amalgamation-concentration mill, at Georgetown, was not operated in 1918, but several cars of lead-gold-silver ore from the Capital mine were shipped to smelters and to the Argo mill at Idaho Springs. The new Colorado-Central 250-ton table-concentration oil flotation mill, near Leavenworth Mountain, was set in motion at the end of the year and several thousand tons of silver-bearing material from the Ocean Wave dump were treated. From the Sceptre mine on Colorado, Republican, and Democrat mountains, considerable lead-zinc-silver ore was shipped to the Jackson, Newton, and Argo concentration mills at Idaho Springs, with product of lead-silver and zinc-lead-silver concentrates.

At Silver Plume, the Wasatch-Colorado concentration mill was actively operated on lead-zinc-silver ores from the Mendota, Frostberg, Dunkirk, Dives, Dives-Pelican, Seven-Thirty, Phoenix-Maine, and other mines. Lead-zinc-silver ore from the Smuggler mine was steadily shipped to the Newton concentration mill at Idaho Springs, with product of lead-silver concentrates, and zinc concentrates carrying some lead and silver. The Denbigh Silver-Lead Mining Co. continued operations on the Terrible mine and shipped considerable lead-zinc-silver ore to the Newton concentration mill at Idaho Springs. Other producing mines at Silver Plume were the Ashby and Payrock.

Idaho Springs district.—In the Idaho Springs district are included the mines about Idaho Springs, including Banner, Cascade, Coral, Jackson, Lower Fall River, Payne's Bar, Spanish Bar, and Virginia subdistricts.

In 1918 the Idaho Springs district produced 33,339 tons of ore, as compared with 40,839 tons in 1917 and with 51,044 tons in 1916. The production of metals in 1918 was $195,843 in gold, 203,239 ounces of silver, 293,300 pounds of copper, and 1,606,211 pounds of lead, having a total value of $585,568, as compared with $724,309 in 1917. In 1918, of the 33,339 tons mined, only 1,334 tons were treated at amalgamation mills (having also concentration equipment) and yielded 239.75 fine ounces of gold and 139 ounces of silver, and 27,833 tons were treated at mills for concentration only, a total to both classes of mills of 29,167 tons, which produced 5,079 tons of concentrates, carrying 6,816.36 fine ounces of gold, 117,939 ounces of silver, 224,572 pounds of copper, and 1,008,432 pounds of lead. Crude ore shipped direct to smelters amounted to 4,172 tons of ore, carrying 2,417.79 fine ounces of gold, 85,161 ounces of silver, 68,728 pounds of copper, and 597,779 pounds of lead.

At the mouth of the Argo tunnel the Argo 20-stamp oil-flotation mill was operated steadily on ores from both Gilpin and Clear Creek counties. The Newton mill was operated steadily on custom ore. Other operating custom mills were the Hudson and Jackson. Other operating mills were the Combination and Little Mattie.

In Gilson Gulch lessees continued operations at the Franklin mine. Through the Argo (Newhouse) tunnel, the Gem mines continued to be the principal producing property in the district. Concentrating ore was shipped from the Golden Edge mine. From mines in Gilpin County, operated through the Argo tunnel, much ore continued to be shipped to the Argo and other mills. The mines were the Tremont (formerly Gunnell), Concrete, and Pozo-Dyke. From mines in Gilpin County, owing to the idleness of the mills in Gilpin County, much ore was hauled by wagon and railroad to Idaho Springs mills. In Virginia Canyon the producing mines were the Bald Eagle, Bellevue-Champion, Crown Point, Treasure Vault, Victor, and Windsor Castle. The Specie Payment mine, opened through the Two Brothers adit, in Virginia Canyon, was also operated. Through the Big Five tunnel lessees operating the Edgar shipped much ore to various mills. On the south side of Clear Creek the Little Mattie mine and mill were operated part of the year, considerable ore was mined and shipped from the Lord Byron mine, and lessees shipped some ore from the Stanley mine.

Montana (Lawson, Dumont) district.—The Montana district in 1918 from 6 mines produced 1,385 tons of ore, yielding $6,599 in gold, 24,024 ounces of silver, 15,232 pounds of copper, and 109,127 pounds of lead, and having a total value of $42,133, as compared with $40,123 in 1917. From the Albro mine, at Dumont, several cars of copper-silver-gold ore were shipped direct to smelters, and a considerable quantity of ore carrying gold, silver, and copper was shipped to concentrating mills at Idaho Springs, the product being copper concentrates. From the Blue Ridge and the Senator mine, at Dumont, several cars of lead-silver ore were shipped to smelters and mills. Other producing mines were the Columbia Chief, Plattz, Murray, and Princess tunnel. From the Jo Reynolds mine, at Lawson, several cars of ore containing a very high content in silver were shipped to smelters and mills. The Little Giant concentration mill, at Lawson, was operated for a short time on silver-lead ores from the Commodore tunnel.

Trail Creek (Lamartine and Freeland) districts.—The Trail Creek district in 1918 from 5 mines produced 2,387 tons of ore, yielding $14,635 in gold, 11,228 ounces of silver, 18,910 pounds of copper, and 419,197 pounds of lead, and having a total gross value of $60,297, as compared with $47,552 in 1917.

Lessees on the Lamartine mine shipped gold-silver ore to mills at Idaho Springs, and lessees on the Gum Tree mine shipped both milling and smelting ore. The New Era concentration mill was operated part of the year and produced lead-silver-gold concentrates. Lessees shipped a considerable quantity of lead-silver-gold ore to smelters and mills.

CONEJOS AND RIO GRANDE COUNTIES.

Platoro-Gilmore-Summitville districts.[1]—No work was done in these districts in 1918.

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[1] For discussion of the geology of the district see Hills, R. C., Ore deposits of the Summit district, Rio Grande County, Colo.: Colorado Sci. Soc. Proc., vol. 1, pp. 20–36, 1883. Raymond, R. W., Statistics of mines and mining in the States and Territories west of the Rocky Mountains, vol. 10, p. 329, 1875. Emmons, W. H., The enrichment of sulphide ores: U. S. Geol. Survey Bull. 529, p. 226, 1913. Patton, H. B., Geology and ore deposits of the Platoro-Summitville mining district, Colo.: Colorado Geol. Survey Bull. 13, 1917.

COSTILLA COUNTY.

Grayback district.[1]—This district has been idle for several years.

CUSTER COUNTY.

Mine production in Custer County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	14	5,881	$7,066	88,687	88,216	228,303	....	$123,861
1918	12	4,326	4,341	108,456	51,292	281,070	13,516	146,652
Increase or decrease, 1918	− 2	− 1,555	− 2,725	+ 19,769	−36,924	+ 52,767	+ 13,516	+ 22,791

The Passiflora mine, near Silver Cliff, continued to produce the bulk of the ore mined in this county. From this mine, reopened in 1917, was shipped in 1918, a large quantity of silver ore, and also considerable lead-silver, copper, and lead-copper ore, both oxidized and sulphide. Other producing mines were the Wisconsin, Ophir, and Victoria-Pioneer, at Rosita; the Black Friday, Buffalo Hunter, Bull Domingo, King of the Carbonates, Lady Franklin, Last Quarter, Luella, and Maxine Elliott, near Westcliffe and Silver Cliff.

DENVER COUNTY.

Denver County is the seat of the Globe lead-copper smelter, which treats ores from nearly all the Colorado counties, except the far southwestern counties, and from many of the Western States, British Columbia, and Canada. The Western Chemical Manufacturing Co.'s sulphuric acid plant, wet-concentration and magnetic concentration mill, and electrolytic zinc plant is located in Denver and treats pyritic and lead-zinc ores mainly from Leadville. There are many small ore-testing and experimental plants in Denver.

No ores are mined in the county, nor is any placer gold recovered from Cherry Creek and Platte River, where gold in sufficient quantities to start the immigration to Colorado was first found.

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[1] For discussion of geology see Patton, Smith, Butler, and Hoskins, Geology of the Grayback mining district, Costilla County, Colo.: Colorado Geol. Survey Bull. for 1909, No. 2, 1910.

DOLORES COUNTY.

Mine production in Dolores County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	8	14,026	$5.213	88,222	519,916	1,772,221	1,701,353	$545,794
1918	9	9,272	3,136	54,249	618,012	517,394	661,253	306,943
Increase or decrease, 1918	+ 1	— 4,754	— 2,077	— 33,973	+ 98,096	—1,254,827	—1,040,100	— 238,851

Lone Cone (Dunton) district.—A small lot of gold ore was shipped from the Geyser mine.

Pioneer (Rico) district.[1]—This district is the principal producing district in Dolores County. The ores are all shipped to smelters and in 1918 were chiefly copper ore, zinc-lead ore, lead ore, and dry silver ore. The copper ores were shipped both to Durango, Colo., and to smelters in Utah. The zinc-lead ore was shipped to Coffeyville, Kans. Some iron sulphide ore (for its iron content only) was shipped to Vanadium, Colo., for use in the treatment of vanadium ores.[2]

The company and lessees on the Rico Argentine property shipped large quantities of copper-silver ore and also a considerable quantity of zinc-lead ore. Copper ore and lead ore were shipped by the Rico-Wellington Co., and the Marmatite Mining & Milling Co. (the principal lessee on the Rico-Argentine property) also shipped some lead ore from the Silver Swan mine. Several cars of copper ore were shipped from the Lucky Boy group. Several cars of silver ore were shipped from the Swansea-Newman group, and lead ore and zinc-lead ore were shipped from the Lillian D mine. A car of copper ore was shipped from the Expectation mine. Reserves of pyrite ore carrying 45 per cent sulphur are said to be extensive in the Rico-Wellington property.[3]

DOUGLAS COUNTY.

In the past there have been small desultory attempts to recover gold by sluicing the gravels and conglomerates in Newlins Gulch, near Parker, and at other localities on Cherry Creek, in Douglas County, with nominal quantities recovered from time to time, but in 1918 no work was done.

At Louviers the E. I. DuPont de Nemours powder plant used in 1917 and 1918 pyritic ores for their sulphur content from Red Cliff and Leadville, from the residues of which some gold and silver were recovered at lead smelters.

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[1] For discussion of geology see Cross, Whitman, and Spencer, A. C., Geology of the Rico Mountains, Colo.: U. S. Geol. Survey Twenty-first Ann. Rept., pt. 2, pp. 7-165, 1900; and Ransome, F. L., The ore deposits of the Rico Mountains, Colo.: U. S. Geol. Survey Twenty-second Ann. Rept., pt. 2, pp. 229-398, 1901.

[2] For discussion of treatment of vanadium ores see Moore, R. B., and Kithil, K. L., A preliminary report on uranium and vanadium: [U. S.] Bur. Mines Bull. 70, p. 74, 1914.

[3] See Min. and Sci. Press, June 1, 1918, p. 769.

EAGLE COUNTY.

Mine production in Eagle County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	22	100,875	[a] $41,187	136,023	53,136	2,426,988	23,715,412	$2,795,469
1918	19	89,675	35,975	241,406	353,041	2,927,099	14,845,341	1,923,332
Increase or decrease, 1918	−3	−11,200	−5,212	+105,383	+299,905	+500,111	−8,870,071	−872,137

[a] Includes small placer production.

There are only two important mining districts in Eagle County, the Brush Creek, a small silver district, near Eagle, from which little ore was shipped in 1918, and the Battle Mountain (or Red Cliff) district, from which the greater part of the production of the county has come. The Red Cliff district is now and has been and will be for some time of importance principally as a producer of zinc ores, with, however, considerable quantities of associated lead, copper, iron, and manganese ores, carrying silver and some gold. The zinc output in 1918 had a gross valuation of $1,350,926, as compared with $2,418,972 in 1917 and with $3,810,699 in 1916.

Battle Mountain (Red Cliff) district.[1]—The Empire Zinc Co.'s magnetic separation mill was operated steadily in 1918 on lead-zinc ores from the Iron Mask mine and other properties, and produced zinc-lead and lead concentrates. A large quantity of zinc-lead ore from other properties of the Empire Zinc Co. was sent to the company's magnetic separation plant at Canon City, and considerable zinc ore was shipped to zinc retort plants, as well as much silver ore, carrying some gold, copper, and lead to lead smelters. Other producing mines were the California, Ground Hog, Foster-Combination, Henrietta, Little May, Pursey Chester, Potvin, Star of the West, T. P. M., Tip Top, and Wyoming Valley-Mystery.

Eagle or Brush Creek district.—Several cars of silver ore were shipped from the Lady Belle and North Dakota mines.

Burns district.—Some development work was done on lode mines in the vicinity of Burns.

EL PASO COUNTY.

At Colorado Springs are located the Golden Cycle and Portland cyanidation mills, which treat almost exclusively the ores of the Cripple Creek district, Teller County.

The Golden Cycle 1,200-ton plant was operated steadily throughout 1918, despite high costs for material and labor and the difficulty of obtaining labor. The Portland 400-ton plant was closed March 31, 1918, and its usual ore supply was diverted to the Golden Cycle mill.

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[1] For discussion of geology see Means, A. H., Geology and ore deposits of Red Cliff, Colo.: Econ. Geology, vol. 10, No. 1, pp. 1-27, January, 1915; also Argall, Philip, Siderite and sulphides in Leadville ore deposits: Min. and Sci. Press, July 11, 1914, p. 52 (describes occurrence of siderite at Red Cliff).

FREMONT COUNTY.

From 3 mines in Fremont County in 1918 there was sold or treated 235 tons of ore, yielding $312 in gold, 639 ounces of silver, 22,377 pounds of copper, and 1,113 pounds of lead, and having a total gross value of $6,557, as compared with $17,478 in 1917.

Several cars of silver ore were shipped from the Oxide and Last Chance mines, in the Texas Creek district. Several cars of copper ore were shipped from the Green Mountain mine, at Parkdale.

GARFIELD COUNTY.

A car of gold ore was shipped from the Gray Eagle mine, near New Castle.

GILPIN COUNTY.[1]

Mine production in Gilpin County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	60	35,289	$397,087	112,585	544,648	815,906	141,490	$723,146
1918	51	23,654	281,384	124,929	456,044	774,972	28,099	576,536
Increase or decrease, 1918	−9	−11,635	−115,703	+12,344	−88,604	−40,934	−113,391	−146,610

The gold production in Gilpin County in 1918 continued to decrease. As compared with the record of 1917, there was an increased quantity of ore to amalgamating mills but a little less gold recovered; a very appreciable decrease in quantity of ore to concentrating mills; a decrease in quantity of concentrates produced, but the concentrates in 1918 contained almost as much gold and twice as much silver and much more copper and lead; smelting ore direct to smelters decreased nearly two-thirds in quantity, more than two-thirds in quantity of gold contained, and nearly 50 per cent in silver content, and very heavily in copper and lead.

In March, 1918, the sampling works at Black Hawk was closed and dismantled, having been in operation since 1878. The lack of smelting ore offered and the idleness of concentrating mills were important factors in determining the closing of the plant, and the closing of the plant resulted in a still greater decrease in ore production. Small shippers were compelled to haul ore to plants at Idaho Springs, which gradually absorbed much of the supply offered for sale.

In the southern districts of Gilpin County only three mills were operated during the year: The Eureka amalgamating-concentration mill throughout the year on Eureka ores only; the Iron City custom concentration mill from January to March only; and the Polar Star custom mill intermittently. In the northern districts, at individual mines there were intermittent operations at the Evergreen, Pioneer, Pennsylvania-Colorado, Cornucopia, and Perigo mines.

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[1] Bastin, E. S., Economic geology of Gilpin County and adjacent parts of Clear Creek and Boulder counties, Colo.: U. S. Geol. Survey Prof. Paper 94, 1916.

Southern districts (*Black Hawk, Central City, Nevadaville, Russell Gulch*).—In the near vicinity of Central City the only producing mine was the East Boston.

In the Enterprise district, the O. C. Redick Co. continued to ship silver ore to smelters and to Idaho Springs mills.

Producing mines in the district embracing Gunnell Hill and Eureka and Prosser gulches were the Concrete, Eureka, and Gunnell. The Concrete and Gunnell mines were operated by the Tremont Co. (subsidiary of the Argo Ore Purchasing & Reduction Co.) and all ore was trammed through the Argo Tunnel to Idaho Springs. The Eureka ore was milled in the amalgamation-concentration mill on the property.

Producing mines in the district embracing the town of Black Hawk, and Gregory, Bobtail, and Bates Hill, were the Americus, Bates, Carr, Centennial, Homer, and Lucky No. 2.

Producing mines in the district embracing Illinois and Leavenworth gulches and the eastern portion of Quartz Hill were the Barnes, German, and Wood.

Producing mines in the Lake Gulch district were the Pittsburg, Pittsburg Extension, Star of the West, and Vivian Notoway. None of these mines made much of a production, the Pittsburg, long one of the important gold producers of the county, having a very small output.

In the vicinity of Nevadaville the producing mines were the Belden, Hubert, Kansas-Burroughs, Orinoco, Pozo-Dyke, and Shanks Tunnel. The Kansas-Burroughs and Pozo-Dyke were worked from the Argo Tunnel level and the ore was shipped to Idaho Springs, but the contents were credited to Gilpin County.

In the Quartz Valley district the producing mines were the Gold Cup, Maggie M., and Robert Emmett-Queen of the West.

In the Russell Gulch district producing mines were the Becky Sharpe, Bosom Plume, Chase, Druid, Frontenac, Gold Lode, Hampton, Pewabic, Powers, Saratoga, Silver Dollar, Subtreasury, Two-Forty, and War Dance.

Northern districts.—The outlying districts in Gilpin County are the Vermilion district, 4 miles northwest of Central City; the Pine district, 7 miles north of Central City, embracing the Perigo, Rollinsville, Lump Gulch, and Moon Gulch sections; the Phoenix district, along the north edge of the county, near the Boulder County line; the Silver Lake district, 5 miles north of Central City; and the Hawkeye district, 7 miles north of Central City and 4 miles east of Apex.

At Apex the Evergreen Mining Co. operated its flotation mill for a time and shipped several hundred tons of high-grade copper concentrates. The Pioneer mill was operated for a short time. The Pennsylvania-Colorado amalgamation-concentration mill was operated for 60 days. A car of ore from the Philadelphia mine was shipped to the Argo mill, Idaho Springs.

On Silver Creek near Apex the Cornucopia Mining & Leasing Co. continued development and operated its mill in testing the ore.

In the Independence district the Perigo mill was remodeled by the addition of flotation cells and operated for a short time. The Smuggler mine and mill were idle.

GRAND COUNTY.

Some development work was done on prospects in Grand County, but no ore was shipped.

GUNNISON COUNTY.

Mine production in Gunnison County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	25	12,671	[a] $6,635	[a] 40,272	180,121	751,000	3,054,990	$465,187
1918	14	6,344	[a] 10,368	[a] 12,880	43,033	300,760	2,349,538	269,039
Increase or decrease, 1918	−11	−6,327	+3,733	−27,392	−137,088	−450,240	−705,452	−196,148

[a] Includes placer production.

Box Canyon district (*Waunita Hot Springs*).[1]—There was no ore shipped from mines in this district and very little development work of any kind was done in 1918.

Cebolla district (*Vulcan, Domingo*).[2]—A very considerable quantity of copper ore was shipped from the Anaconda mine. At the Good Hope mine, lessees unwatered the property to the 600-foot level, did 400 feet of drifting, rebuilt the shaft house, and shipped several hundred tons of gold-silver ore.

Cochetopa district (*Sillsville*).[3]—No work of any kind was done in this district.

Elk Mountain district.[4]—Lessees shipped a large quantity of zinc carbonate ore from the Doctor mine, on Spring Creek. This mine was operated every day of the year and development consisted of an extension of the main adit from 650 feet to 850 feet and the driving of 300 feet of drifts. A car of silver ore was shipped from the Woodrow Wilson prospect.

Gold Brick district (*Ohio City*).[5]—The Carter group of mines was operated from January 1 to November 12, 1918, and was then shut down on account of labor conditions and of the high costs of material as balanced against the fixed price of its gold product. This mine is opened by an adit 8,000 feet long, 5,000 feet of drifts, and an upraise of 1,400 feet. Much development work was done in 1918, but only one car of concentrates was produced and shipped from a short operation of the amalgamation-concentration mill. A car of lead-silver ore was shipped from the Queen mine. Two small cars of gold-silver ore were shipped from the Velvet mine.

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[1] For discussion of geology see Hill, J. M., Notes on the economic geology of southeastern Gunnison County, Colo.: U. S. Geol. Survey Bull. 380, pp. 21-40, 1909.

[2] Harder, E. C., Manganese deposits of the United States: U. S. Geol. Survey Bull. 380, p. 273, 1909; U. S. Geol. Survey Bull. 427, p. 150, 1910. Leith, C. K., Iron ores of the western United States and British Columbia; U. S. Geol. Survey Bull. 285, p. 197, 1906.

[3] See Hill, J. M., op. cit.

[4] Harder, E. C., op. cit., pp. 188-198. Emmons, S. F., Cross, Whitman, and Eldridge, G. H., U. S Geol. Survey Geol. Atlas, Anthracite-Crested Butte folio (No. 9), 1894.

[5] Hill, J. M., op. cit.

Quartz Creek district (*Pitkin*).[1]—A car of gold-silver ore was shipped from the Terrible mine, opened by an incline shaft 160 feet deep.

Rock Creek district (*Marble*).[2]—Owing to the cessation of operations of the Crystal River Railroad to Marble, operations were at a standstill in the Rock Creek district.

Tin Cup district.[3]—One small lot of silver-lead ore and a car of silver ore were shipped from the El Capitan mine.

Tomichi district (*Whitepine*).[4]—The Akron Mines Co., operating the May, May Mazeppa, Ensign, and North Star mines, continued development and construction work throughout the year, installing a new mill (dismantling the old mill and incorporating its parts in the new mill), extending Akron crosscut adit, in preparation for milling in 1919. During this development campaign, lead-zinc ore was shipped to the River smelter at Florence and to the Western Chemical Co.'s plant at Denver. The adit extension is to develop also the Eureka group, acquired under lease and bond.

HINSDALE COUNTY.[5]

Mine production in Hinsdale County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	13	517	$1,136	7,721	6,099	209,616	4,117	$27,610
1918	18	5,222	6,249	22,245	18,308	767,972	....	87,542
Increase or decrease, 1918	+5	+4,705	+5,113	+14,524	+12,209	+558,356	−4,117	+59,932

Galena district.—Several cars of silver ore were shipped from the Highland Chief mine. At the Hidden Treasure property the mill was thoroughly overhauled and new equipment installed. This remodeled mill with equipment of crusher, rolls, trommels, Wilfley tables, ball mill, classifier, and flotation cells, was operated on lead-silver ore and yielded a very good grade of lead-silver concentrates. The mine is opened by a 923-foot shaft. The plans for 1919 include retimbering the shaft and drifts and driving a long adit. Other producing mines were the Excelsior, Frank, Hough, Golconda, Independence, Ocean Wave, and Varden Belle.

Lake district.—Several cars of gold-silver concentrates were produced from milling operations of dump ores from the Golden Fleece mine. Early in 1918 the Ulay mine was pumped out for inspection by the American Smelting & Refining Co., but on November 1, 1918, all work was stopped on both the Ute and Ulay mines, after shipping several hundred tons of lead-silver ore. Other producing mines were the Belle of the West, California, Emerald Isle, Grove, and Ilma.

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[1] See Hill, J. M., op. cit.

[2] Emmons, S. F., Cross, Whitman, and Eldridge, G. H., U. S. Geol. Survey Geol. Atlas, Anthracite-Crested Butte folio (No. 9), 1894. Covers merely extreme source of Rock Creek, and geology discussed only in general way.

[3] See Hill, J. M., op. cit.

[4] For discussion of geology see Crawford, R. D., Geology and ore deposits of the Monarch and Tomichi districts, Colo.: Colorado Geol. Survey Bull. 4, 1913. Hill, J. M., op. cit.; Harder, E. C., op. cit.; Leith, C. K., op. cit.

[5] For discussion of geology see Irving, J. D., Ore deposits in the vicinity of Lake City, Colo.: U. S. Geol. Survey Bull. 260, pp. 78–84, 1905; Ore deposits of the Ouray district, Colo.: U. S. Geol. Survey Bull. 260, pp. 50–77, 1905. Irving, J. D., and Bancroft, Howland, Geology and ore deposits near Lake City, Colo.: U. S. Geol. Survey Bull. 478, 128 pp., 1911. Larsen, E. S., The economic geology of Carson Camp, Hinsdale County, Colo.: U. S. Geol. Survey Bull. 470, pp. 30–38, 1911. Woolsey, L. H., Lake Fork extension of the Silverton mining area, Colo.: U. S. Geol. Survey Bull. 315, pp. 26–30, 1907.

JACKSON COUNTY.

Pearl district.[1]—Development work only was done at the Wolverine mine during 1918 in preparation for the installation of a milling plant.

JEFFERSON COUNTY.

A test car of copper ore was shipped from the Copper Creek property, below Evergreen

LAKE COUNTY.

Mine production in Lake County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
			Placer.	Deep.					
		Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	88	422,428	$110,325	$1,064,894	[a]2,184,000	2,182,623	18,301,802	60,254,333	$11,290,588
1918	92	355,840	92,066	751,173	[a]2,290,121	1,626,534	22,469,915	46,715,736	9,381,610
Increase or decrease, 1918	+4	−66,588	−18,259	−313,721	+106,121	−556,089	+4,168,113	−13,538,597	−1,908,978

[a] Includes placer production.

Lake County in 1918 produced less gold, zinc, and copper than in 1917, but showed an increase in lead and silver. The decrease in zinc was due to the exhaustion of the large easily worked zinc carbonate deposits and the lead and silver increase came from the reopened lead carbonate deposits in the Down Town district. Up to November, 1918, there was also a large quantity of iron-manganese ores shipped to steel plants in the East and at Pueblo, Colo.

The quantity of ore under discussion in this report (not including the iron-manganese ore used in the steel industry) mined in 1918 was 66,588 tons less than in 1917, following a decrease of 54,812 tons in 1917, as compared with that mined in 1916. The greatest decrease in 1918 was in zinc carbonate ores and the next greatest decrease was in zinc-lead sulphide ores; iron pyrite ores (both those with excess of iron over silica and those with excess of silica over iron) decreased slightly in quantity and heavily in content of gold, but increased in content of silver; the lead oxidized ores showed the heaviest increase.

This county continued to rank first in the production of silver, copper, lead, and zinc; in the production of gold it again ranked third, following Teller and San Miguel. Of the State total, Lake County produced 7 per cent of the gold, 32 per cent of the silver, 26 per cent of the copper, 34 per cent of the lead, and 52 per cent of the zinc.

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[1] Spencer, A. C., Reconnaissance examination of the copper deposits at Pearl, Colo.: U. S. Geol. Survey Bull. 213, pp. 163-169, 1903.

The Derry Ranch dredge, at the mouth of Rock Creek, where it empties into Arkansas River, 12 miles below Malta, which was operated for the first time in 1915, continued steadily during the year 1918, as it had done in 1916 and 1917. This operation is the first revival of the placer industry since the early sluicing and hydraulic operations in California Gulch immediately following the discovery of gold in that district in 1860.

Lake County includes the Leadville, St. Kevin, Sugar Loaf, Twin Lakes, Lackawanna Gulch, Big English Gulch, Western Pass, Wortman, and Arkansas River placer districts. The Leadville district includes Fryer Hill, Carbonate Hill, Breece Hill, Iron Hill, North Iron Hill, Printer Boy Hill, Ball Mountain, California Gulch, Iowa Gulch. and South Evans Gulch.

LEADVILLE DISTRICT.[1]

GENERAL FEATURES.

Of a total of 355,840 tons mined in 1918 in this county 353,473 tons was from the Leadville district. The yield was $710,650 in gold, 2,232,413 ounces of silver, 1,619,781 pounds of copper, 22,373,183 pounds of lead, and 46,685,901 pounds of zinc, and the value was $9,180,062 out of a total county production of $9,381,610. In 1917 the yield was $1,000,116 in gold, 1,940,983 ounces of silver, 2,171,242 pounds of copper, 17,844,500 pounds of lead, and 59,669,068 pounds of zinc, and the value was $10,813,107 out of a total county production of $11,290,588.

The output of zinc carbonate ores decreased from 69,238 tons carrying 19.84 per cent of zinc in 1917 to 21,292 tons carrying 18.64 per cent in 1918.

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[1] For discussion of geology see Emmons, S. F., Geology and mining industry of Leadville, Colo.: U. S. Geol. Survey Mon. 12, 1886; Emmons, S. F., and Irving, J. D., The Downtown district of Leadville, Colo.: U. S. Geol. Survey Bull. 320, 1907; Argall, Philip, Siderite and sulphides in Leadville ore deposits: Min. and Sci. Press, July 11 and 25, 1914, pp. 50-54, 128-135; Harder, E. C., Manganese deposits of the United States: U. S. Geol. Survey Bull. 380, p. 273, 1909; U. S. Geol. Survey Bull. 427, pp. 137-143, 1910; Loughlin, G. F., The oxidized zinc ores of Leadville, Colo.; U. S. Geol. Survey Bull. 681, 1918.

Classification of Leadville ores in 1918.

Character.	Quantity.	Percentage.
Sulphide:	*Short tons.*	
Zinc-iron-lead (zinc blende, pyrite, and galena)	125,281	35
Iron (pyrite, with gold, silver, copper, and lead and some zinc blende) [a]	117,746	35
Iron (pyrite, with gold, silver, lead, and copper over 2½ per cent of dry copper, with some zinc blende) [a]	4,441	
Total sulphide	247,468	70
Oxide:		
Lead	45,508	13
Copper	3,898	1
Iron flux	2,081	1
Iron-manganese-flux	26,955	7
Siliceous	6,271	2
Zinc	21,292	6
Total oxide	106,005	30
Grand total	353,473	100

Character.	Quantity.	Recovered contents.				
		Gold.	Silver.	Copper.	Lead.	Zinc.
Sulphide:	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Zinc-iron-lead	125,281	[b] 2,089.60	[b] 302,785	[b] 11,490	[b] 7,307,290	[c] 40,334,218
Iron pyrites [d]	91,803	5,754.37	1,112,765	558,387	1,475,416	
Lead sulphide	4,441	1,459.68	37,658	33,545	832,450	
Siliceous sulphide (carrying pyrite)	25,943	18,422.13	223,279	526,000	293,691	
Oxide:						
Lead (siliceous excess)	27,957	3,319.05	212,211	67,520	7,494,808	
Lead (iron excess)	17,551	114.10	85,284	8,005	3,948,605	
Copper	3,898	405.30	10,019	402,060	34,760	
Iron flux	2,081		18,257	3,611	14,296	
Iron-manganese-flux	26,955	291.05	172,475	1,569	783,906	
Siliceous	6,271	1,741.68	57,420	7,594	187,966	
Zinc	21,292					[c] 6,351,683
Metallics (sulphide and oxide) [e]		780.74	260			
	353,473	34,377.70	2,232,413	1,619,781	22,373,183	46,685,901

Character.	Average recovery.				
	Gold.	Silver.	Copper.	Lead.	Zinc.
Sulphide:	*Ounces per ton.*	*Ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Zinc-iron-lead	[f] 0.030	[f] 4.33	([f])	[f] 6.25	[f] 24.90
Iron pyrites	.063	12.12	0.30	.80	
Lead-sulphide	.329	8.48	.38	9.37	
Siliceous sulphide (carrying pyrite)	.710	8.61	1.01	.57	
Oxide:					
Lead (siliceous excess)	.119	7.59	.12	13.40	
Lead (iron excess)	.007	4.86	.02	11.25	
Copper	.104	2.57	5.16	.45	
Iron flux		8.77	.09	.34	
Iron-manganese flux	.011	6.40		1.45	
Siliceous	.278	9.16	.06	1.50	
Zinc					[g] 18.64
Metallics (sulphide and oxide)					

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[a] The greater part of the iron pyrite carries iron in excess of silica and also high silver but low gold content. A large quantity of iron pyrite carries silica in great mass over iron and high gold but low silver content. Some of the iron pyrite approaches the zinc-iron-lead classification (when zinc market gives higher returns or sale as lead-zinc sulphide than as lead sulphide to lead smelters), and vice versa.

[b] Recovered as lead and iron concentrates and in zinc residues.

[c] Zinc in terms of recovered retort zinc and recovered zinc in zinc oxide.

[d] Includes both ore to lead plants and that used for making sulphuric acid from which residues were returned to lead plants.

[e] May include some Cripple Creek and Park County metallics.

[f] Average assay of greater part of original ore for which data were available. (Lead "wet" assay.)

[g] Average assay of original content; no deductions for loss in smelting. All to zinc plants.

The course of treatment of Leadville ores from mine mouth to market was shown graphically in Mineral Resources for 1911, Part I, page 547, figure 1. With the exception of the quantity of ore, the flow sheet for 1911 applies for 1918 in nearly all the details.

During 1918 the Western Zinc Concentrating Co.'s zinc-oxide plant was operated continuously on low-grade zinc carbonate ores. The A. V. smelter of the American Smelting & Refining Co. was operated steadily, but with only part of the furnaces in use, on Leadville ores and ores from other parts of Colorado as well as on ores from Idaho and elsewhere.

The Downtown mines continued to ship heavily from the properties unwatered in 1916, and large shipments were made from the Greenback and Mikado shafts, unwatered in 1917. The Western Mining Co. ceased operations at the Wolftone mine December 1, 1918.

MINES REVIEW.

California Gulch, Iron Hill, and Breece Hill mines as opened by the Yak Tunnel.—The Yak Tunnel starts in California Gulch and unwaters and develops a large number of mines along its course through Iron and Breece hills toward the Mosquito Range. Of the mines operated by the Yak Co. itself, much of the ore comes from the Cord winze below the tunnel level. Other important mines worked from the tunnel were the Comstock, Fortune, Resurrection, Sierra Nevada, and White Cap. The bulk of the ore was iron sulphide, which was shipped to lead smelters in Colorado. Much iron pyrite, chiefly valuable for its sulphur content but also carrying considerable silver and some lead and zinc, was shipped to plants for the manufacture of sulphuric acid, the roasted residue finally reaching lead plants. Much lead-zinc sulphide ore was shipped to the Western Chemical Co., Denver. Much low-grade zinc carbonate ore was also shipped to the local zinc-oxide plant.

Iron Hill.—On October 13, 1917, the Moyer mine, of the Iron Silver Mining Co., was closed down after many years of active operation. The report of the Iron Silver Mining Co. for the year ending December 31, 1918 (dated Feb. 21, 1919), says of the Tucson mine, also a property which has been worked for years:

> Two years ago the ore bodies of this mine began to show signs of exhaustion, and the last annual report described the outlook for the Tucson, at the beginning of 1918, as unfavorable, due to the scarcity of ore then available.
>
> Continued operations failed to bring any improvement in the condition of the mine, and at the expiration of the first quarter of the year 1918 practically all the commercial grade ore had been mined from the known deposits. Work was continued until July, when the mine was closed down following several months of unprofitable operation, during which certain development that was deemed essential was completed. The decision to close this mine was not reached until all known sources of ore had been exhausted and the areas considered to have possibilities of containing additional deposits had been prospected. The final development proved unsatisfactory and the mine can be considered to be worked out of present commercial grade ore.
>
> With the closing of the Tucson mine all operations by the company on its original mining property became discontinued and attention has since been concentrated upon the development and exploitation of the newly acquired holdings.

The Louisville mine was operated from January to October, when closed, and only a small quantity of ore was mined from the A. Y. and Minnie. Iron sulphide ores were shipped from the Adelaide and from the Humboldt on North Iron Hill.

Graham Park.—The Iron Silver Mining Co. reports on its newly acquired property:

> Following the purchase of this property in 1916 an extensive amount of work, all of which has been fully described in the two previous annual reports, was necessary to bring the mine to the productive stage. The first shipment of ore was made in June, 1917, and a limited tonnage was produced during the remainder of that year. It was not, however, until July, 1918, that sufficient ore was developed and the workings opened out to such an extent as would permit the mining of a satisfactory daily output. During the closing half of the year production has been maintained at the rate of 3,500 tons per month and this output has enabled the mine to show a gratifying earning capacity.
>
> In the previous annual report a description was given of a zinc-sulphide ore body then opened on the 1,000-foot level and which dipped so strongly beneath this level that a lower level was turned off from the shaft at the 1,075-foot point to prove it. The 1,075-foot level has since cut this same ore body and the work done from that level during 1918 has developed and blocked out an ore shoot of considerable extent.
>
> This ore shoot has now been proved for a continuous length of 680 feet, trending in a southwesterly direction across our R. A. M. and Cyclops claims. Its northeast end terminates against the Mikado fault plane where the deposit develops its maximum width and thickness and, also, contains the best-grade ore. In the vicinity of the fault the ore body attains a width of 220 feet and a thickness of 30 feet, but both dimensions diminish as the shoot extends away from the fault, until it is but 50 feet wide and 5 feet thick on the south side-line of the Cyclops claim.
>
> The ore is a heavy, mixed sulphide of zinc, lead, and iron carrying a few ounces of silver and valuable chiefly for its zinc content. It is estimated that this deposit originally contained 80,000 tons of ore of which amount practically one-half has been mined to date.
>
> This body of ore is contained in the upper portion of the Blue limestone and, for lack of depth at the Mikado shaft, is the only ore of consequence so far opened on the Marian property. Other deposits are known to exist in the White limestone formation at greater depth, and certain work is now under way to reach these.
>
> Operations on the adjoining property of the Alleghany Mining Co., which we hold under a lease, disclosed the ore so far opened there to be rather irregular in its occurrence and of no great extent. Mining, however, produced 4,326 tons of zinc ore from this source in 1918 which, after paying royalty, returned us the sum of $35,032.50. This ground is still considered to have good possibilities and conditions will now permit of its being prospected with greater dispatch.
>
> Underground work during the past year continued to be hampered by the very heavy nature of the ground adjacent to the Mikado fault. The main haulage levels had to be continually repaired to keep them open, and mining and hoisting were suspended for three weeks in June to permit of retimbering 150 feet of the shaft that has been crushed out of shape by the fault movement. Additional repairs will soon be required in this portion of the shaft.
>
> Abandonment of operations in the Fryer Hill region, north of the Marian, caused us some trouble through the water, that was formerly pumped there, rising and seeping into our workings in such manner as to make most of them wet and add to the difficulty of holding the ground. The increased flow from this source amounts to 150 gallons per minute, but we have the pumping capacity to easily take care of it.
>
> Aside from these adverse features the general condition of the mine is good and there is enough ore, actually proved, to maintain the present rate of production for this year, at least.
>
> Because of the difficulty and expense of keeping the Mikado shaft, and the levels therefrom, in safe and satisfactory operating condition, and for the further purpose of developing and exploiting the Southern area of our new property to better advantage, it has been deemed expedient to provide another working shaft. Such a shaft had already been advantageously located, 1,270 feet southwest of the Mikado, on the Pyrenees claim, a property in which we own a substantial interest and a long term lease covering the remaining ownership interests. This old Pyrenees shaft was sunk some 20 years ago to a depth stated to be over 1,200 feet but, for some reason or other, probably because of the large volume of water encountered, very little development was then done from it. With the exception of one unsuccessful attempt to pump it out in 1908, nothing had been done there since the original work. The old shaft was of small cross section, being only 4 by 9 feet in the clear, and we realized that it would have to be enlarged to provide a satisfactory working size. As it is well located and far enough removed from the Mikado fault never to experience any trouble from that source, we decided to utilize it rather than to go to the greater expense of sinking an

entirely new shaft. Light equipment which we had on hand was moved to the premises in July last and the work of enlarging and retimbering the old shaft to one having a cross section of 4 feet 8 inches by 12 feet, divided into three compartments, was then commenced. Progress has been slower than we anticipated because the old shaft was found to be filled with numerous pipe lines, cables, and sinker pumps left there by former operators; also, considerable débris, all of which impeded the work, but the new shaft had been completed to a depth of 825 feet by the end of the year and is now nearing the 1,200-foot point. In the meantime a modern surface plant has been erected on the surface in which most of the machinery and equipment formerly employed on the Tucson mine has been used.

When completed, with pumping plant in place and levels driven to connect with the Marian workings, this will become the main working shaft of the property.

The close of 1918 brought to zinc-mine operators the most discouraging operating conditions and the lowest prices for ore they have ever had to contend with. Freight and smelting costs have advanced the same as mining costs and the producer has been forced to assume these added charges against his ore. Spelter production has been maintained at a rate in excess of the demand with the natural result that price quotations for this metal have shown a steady decline until, at the present time, it is selling at prices below the actual cost of production. Under these conditions very few of the regular buyers are in the market for ore. Such offers as are being made are upon terms that impose a substantial reduction over even the prewar base prices.

When these distressing conditions became apparent the policy of shutting down temporarily was considered but deemed inadvisable. The mine is a very wet one and the ground so extremely heavy that the cost of draining and maintaining the workings over an indefinite, unproductive period might finally prove most unprofitable; while a complete cessation of all operations would, in all probability, render the cost of recovering the workings prohibitive.

By accepting the drastic ore-price reductions now in effect we have been able to secure a market for the disposal of our product upon terms that will materially decrease the monthly earning capacity of the mine but still leave a slight margin of profit at present spelter prices. In the meantime, we can only hope that economic conditions may improve to the extent that operations can be continued on a more satisfactory basis.

Iron Silver Mining Co.'s production, 1918.

	Quantity (short tons wet weight).	Value.
Marian mine	25,805	$306,259
Alleghany lease	4,327	35,033
Tucson mine	3,094	30,905
Leases on the property	23,207	171,212
	56,433	543,409

Metal content of Iron Silver Mining Co.'s production, 1918.

Gold	ounces	402
Silver	do	163,809
Lead	pounds	2,661,131
Zinc	do	21,847,947
Iron and manganese (combined)	do	6,446,825
Copper	do	902

Ball Mountain.—Several hundred tons of lead-silver sulphide ore were shipped from the Sunday mine.

Breece Hill.—Breece Hill and South Evans Gulch embrace the chief gold mines of the district. Lessees on the property of the Ibex Mining Co. continued to ship large quantities (but less than formerly) of all the various grades of ore, including some metallic gold. Large quantities of iron-sulphide ore were shipped by the Garbutt Leasing Co., from the Garbutt, Maud Hicks, and Dennis and Nonie claims. Other producing mines were the Breece, Fanny Rawlings, Highland Chief, Highland Mary, and St. Louis tunnel.

South Evans Gulch and Little Ellen Hill.—The ores of this vicinity carry an appreciable content of gold and silver. Siliceous ores were shipped from the New Monarch and from the Valley mine.

Carbonate Hill.—The bulk of the zinc carbonate shipments from Leadville continued to come from mines on Carbonate Hill. In December, 1918, however, the various mines of the Western Mining Co., since 1910 the chief shipper of zinc carbonate ores, were closed, with a greatly reduced output for the year in comparison with previous years. The Star Consolidated Mines Co., formerly a shipper of large quantities of zinc carbonate, shipped in 1918 only a few hundred tons of this class of ore, but shipped large quantities of iron manganese ores to eastern steel plants until the armistice. There were also shipped large quantities of iron-manganese ore to steel plants from the Catalpa, Carbonate, Crescent, and Yankee Doodle mines. Large quantities of lead-zinc sulphide ore from the Mahala and other mines of the Western Mining Co. were shipped to the milling plant and also the zinc plant of the United States Zinc Co., at Pueblo.

Fryer Hill.—Zinc carbonate ores, lead carbonate ores, and iron-manganese ores were shipped from mines in this hill, chief of which were the All Right (or Fairview), Chrysolite, Dunkin, Little Chief, Little Silver, Matchless, May Queen, and Robert E. Lee. From the various claims of the Leadville unit of the United States Smelting, Refining & Mining Co., unwatered and rêtimbered in 1916, was shipped a variety of ores until July, 1918, when the properties were abandoned by that company.

Printer Boy Hill.—Oxidized ores were shipped from the Lilian mine.

Rock Hill.—Lead oxidized ore and iron manganese ore, both for fluxing purposes and to steel plants, was shipped from the Nisi Prius mine, and iron manganese fluxing ores and lead siliceous oxidized ore from the La Plata group.

Iowa Gulch.—Several cars of sulphide ore were shipped from the First National mine.

Downtown district.—Large quantities of iron-manganese fluxing ore, iron-manganese ore to steel plants, zinc carbonate, zinc-lead sulphide, and lead oxidized ores were shipped from the various properties under the control of the Down Town Mines Co., all operated through the Penrose shaft. The C. J. Dold Co. continued to ship iron-manganese ores both for fluxing purposes and to steel plants from the "Northern" mine. Much high-grade manganese-iron ore was shipped to steel plants from the A. V. mine.

OTHER DISTRICTS.

St. Kevin, Sugar Loaf, and Independence districts.—From the early days of mining in Lake County there has been production from the district lying along the base of the Sawatch Range, including St. Kevin and Sugar Loaf Mountains. In 1918, from the Griffin mine was shipped lead-silver sulphide and lead-zinc sulphide ores. Both sulphide and oxidized silver ores were shipped from the Dinero and from the Bartlett Tunnel property (Prince of Wales).

Twin Lakes and Lackawanna Gulch districts.—From the Ozark group, the Mountain Champion Mining Co. shipped direct to smelters a considerable quantity of sulphide ore carrying a high content of gold. The Mount Champion 100-ton amalgamation and concentration mill[1] was not operated.

Weston Pass district.—No shipments of ore were made from the zinc and lead carbonate deposits at the head of Weston Gulch.

Wortman (*or Alicante district*).—Lead ore was shipped from the Burma (or John Reed) group.

Arkansas Valley dredge district.—At the mouth of Rock Creek, 12 miles from Leadville, the Derry Ranch 5 cubic foot bucket dredge continued successful operations in 1918.

LA PLATA COUNTY.

Mine production in La Plata County, Colo., in 1917 and 1918.

Year.	Number of producing mines..	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917..................	21	1,648	$25,281	15,324	25,795	3,745	$45,272
1918..................	14	300	7,378	6,415	668	3,000	14,171
Decrease, 1918.	7	1,348	17,903	8,909	25,127	745	31,101

All the ore produced in this county was shipped direct to smelters.

La Plata (*California*) *district.*[2]—The mines of this district are located in the La Plata Mountains, in the drainage basin of La Plata River, 10 miles from Hesperus, the shipping point on the Rio Grande Southern Railroad.

Only a few small shipments were made from this district in 1918. The Valley View Consolidated Mining Co., lessee on the Valley View and Idaho mines, shipped several cars of gold-silver ore. Small lots of ore were shipped from the Bay City, Comstock, Cora G., Cumberland, Durango Girl, Jumbo, Monitor, Small Hopes, and Tippecanoe mines.

In Montezuma County, but in the La Plata district, on the west slope of the La Plata Mountains, no ore was mined in 1918.

Needle Mountains district.—A small lot of lead-silver ore was shipped from the Coston mine.

Cave Basin district.—The Cave Basin district, from which there was a small output in 1913, is located on the San Juan National Forest, about 20 miles north and east of Bayfield, in La Plata County, near the La Plata-Hinsdale county line, between Vallecito and Pine rivers. Development work only was done in this district in 1918.

LARIMER COUNTY.

No work was done on the prospects in this county near Masonville, or in the Christ Mountain district, or in the Rabbit Creek district.

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[1] For description see Becker, J. A., Colorado Bur. Mines Thirteenth Bienn. Rept., for 1913-14, p. 95, 1914.

[2] For discussion of geology see Cross, Whitman, and others, U. S. Geol. Survey Geol. Atlas, La Plata folio (No. 60), 1899; Emmons, W. H., The Neglected mine, and near-by properties, Durango quadrangle, Colo.: U. S. Geol. Survey Bull. 260, pp. 121-127, 1905.

MESA COUNTY.

No production was made in the Unaweep district[1] in 1918.

MINERAL COUNTY.

Mine production in Mineral County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	12	32,755	$10,101	361,517	19,297	1,305,744	54,971	$431,160
1918	11	28,372	13,943	640,959	3,490	989,620	....	726,027
Increase or decrease, 1918	−1	−4,383	+3,842	+279,442	−15,807	−316,124	−54,971	+294,867

Creede district.[2]—The Creede district embraces the most important deposits of Mineral County, and in 1918 the output of silver increased 78 per cent.

The American Smelting & Refining Co. had a lease and bond on a large acreage at Creede and shipped much silver ore from various properties. The Humphrey concentration-flotation mill was operated for a period, the product being lead concentrates. The Monon Mining Co. shipped a large quantity of silver ore from the Quintette-Monon group. Smelting ore shipped from this district increased from 18,420 tons in 1917 to 27,151 tons in 1918.

The producing mines were the Alpha, Amethyst, Bachelor, Commodore, Corsair, Equity, Holy Moses-Solomon, Last Chance, Manitoba, Mollie S., Monon, New York, Park Regent, and Silver King.

MOFFAT COUNTY.[3]

Craig district.—No placer gold was recovered in the district in 1918.

Douglas Mountain district.—Some development work was done in this district in 1918.

Fourmile district (*near Baggs, Wyo.*).—Producing placers in this district in 1918 were the Buckeye and Hawkeye, and the Timberlake.

Lay district.—Only small development work was done on the placer deposits in this district.

MONTEZUMA COUNTY.

(See La Plata County.)

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[1] For discussion of geology see Butler, B. S., Notes on the Unaweep copper district, Colo.: U. S. Geol. Survey Bull. 580, pp. 19–23, 1914; Emmons, S. F., Copper in the "Red Beds" of the Colorado Plateau region: U. S. Geol. Survey Bull. 260, p. 227, 1905.

[2] For discussion of the geology of the district see Emmons, W. H., and Larsen, E. S., A preliminary report on the geology and ore deposits of Creede, Colo.: U. S. Geol. Survey Bull. 530, pp. 42–65, 1913.

[3] White, C. A., On the geology and physiography of a portion of northwestern Colorado and adjacent parts of Utah and Wyoming: U. S. Geol. Survey Ninth Ann. Rept., p. 691, 1889; Gale, H. S., Gold placers near Lay, Routt County, Colo.: U. S. Geol. Survey Bull. 340, pp. 84–85, 1908; Carnotite and associated minerals in western Routt County, Colo.: Idem, pp. 257–262.

MONTROSE COUNTY.[1]

No shipments of copper ore were made from the Paradox Valley in 1918, but development work was done on the property formerly called the La Sal mines, near Bedrock.

OURAY COUNTY.[2]

Mine production in Ouray County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	52	86,523	$92,831	868,097	179,553	2,031,721	532,794	$1,086,234
1918	38	79,653	107,645	801,359	153,117	2,587,915	39,297	1,134,142
Increase or decrease, 1918	−14	−6,870	+14,814	−66,738	−26,436	+556,194	−493,497	+47,908

Red Mountain district.—The Red Mountain district in 1918 from 11 mines produced 2,457 tons of ore, yielding $2,339 in gold, 17,342 ounces of silver, 106,785 pounds of copper, 218,831 pounds of lead, and 39,297 pounds of zinc, with a total value of $65,170, as compared with $123,318 in 1917.

The revival of mining begun in this district in 1916 carried through 1917 and 1918, although the output in 1917 was larger than in 1918. The Red Mountain Mines Co. (subsidiary of the Mary Murphy Gold Mining Co., of Romley), shipped from the Genessee mine considerable lead-copper-silver ore to smelters and to the North Star custom mill at Silverton. At the Barstow mine several hundred tons of ore were milled and lead-copper concentrates shipped. Fluorspar was also shipped from the Barstow mine. Other shipping mines were the Beaver & Belfast, Gray Eagle, Hero, Indiana, Paymaster, Royal Consort, and Snowflake.

Sneffels district.—Although the Camp Bird mine remained nonproductive during 1918, this district continued to be the principal producing district in Ouray County. In 1918, from five mines were sold or treated 73,409 tons, from which were recovered $84,707 in gold, 659,227 ounces of silver, 26,883 pounds of copper, and 1,900,746 pounds of lead, with a total value of $885,527, as compared with $792,107 in 1917, with $1,044,262 in 1916, and with $1,259,367 in 1915.

The Atlas 100-ton, 20-stamp, Hardinge ball mill, gravity concentration and flotation plant[3] was operated steadily except for 20 days in December on account of the epidemic of influenza. The Smuggler Union Mining Co., with properties in San Miguel County, continued to extract ore from the Humboldt mine in Ouray County through the extension of the Smuggler Union workings, and to treat the ore at the Smuggler Union mill in San Miguel County. Fortunately, this company keeps a separate record of the bullion and concentrates derived from the Ouray property, so Ouray is credited with a very appreciable output of silver and gold produced by San Miguel County mills. The concentration mill (built underground) of the Mountain Top mine was operated throughout the year with half a crew of men owing to the scarcity of labor and produced a considerable quantity of high-grade silver concentrates. Lead ore containing a very high content of silver was shipped direct to smelter from this mine. Lead ore direct to smelter was shipped from the Cumberland-Revenue mine and from the Hidden Treasure mine.

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[1] Boutwell, J. M., Vanadium and uranium in Utah: U. S. Geol. Survey Bull. 260, pp. 202–203, 1905. Hillebrand, W. F., and Ransome, F. L., On carnotite and associated vanadiferous minerals in western Colorado: U. S. Geol. Survey Bull. 262, pp. 14–16, 1905; Emmons, W. H., The Cashin mine, Montrose County, Colo.: U. S. Geol. Survey Bull. 285, pp. 125–128, 1906.

[2] For discussion of geology see Cross, Whitman, and Howe, Ernest, U. S. Geol. Survey Geol. Atlas, Ouray folio (No. 153), 1907; Silverton folio (No. 120), 1905; Irving, J. D., Ore deposits of the Ouray district Colo.: U. S. Geol. Survey Bull. 260, pp. 50–77, 1905; Ransome, F. L., A report on the economic geology of the Silverton quadrangle, Colo.: U. S. Geol. Survey Bull. 182, pp. 1–165, 1901.

[3] For description of mill see Carroll, F., Colorado Bur. Mines Thirteenth Bienn. Rept., for 1913–14, p. 71, 1914; Min. and Sci. Press, June 24, 1916, pp. 953–954.

The seventeenth ordinary general meeting of Camp Bird (Ltd.), held in London, November 28, 1918, received the following report:[1]

> With regard to the position at the Camp Bird mine, their operations at that property were limited to the work that was being done by the Tunnel Co. They already had been advised that the Camp Bird vein was intersected in the low level tunnel in June, 1918, at a point 11,000 feet from the portal. It would be recalled that this tunnel was directed to strike the vein at a point about midway between the two main shoots of ore worked at and above the third level in the Camp Bird mine, and as the ore body on the latter level was practically barren for several hundred feet on either side of that portion corresponding to the point of intersection in the low level tunnel, it was not a matter for surprise or disappointment to find a similar condition existing at the latter horizon. In order to make certain that the vein encountered at 11,000 feet was the true vein and not a branch, the tunnel was extended to 11,072 feet, before commencing to drive east and west. With the exception of an extension of 77 feet to the west, undertaken to permit of such work being continued later without interference with transportation in the tunnel, their energies had been confined to pushing the drive east in order that connection might be effected with No. 3 shaft workings, and for the purpose of giving ventilation. The latest advices to hand indicated that the drive east was now extended to a distance of 956 feet from the tunnel intersection, leaving approximately 450 feet to be driven to reach a point opposite No. 3 shaft. As the level being driven was 1,450 feet below No. 3 level, and the ninth level 1,000 feet below the latter, there would be necessitated a rise of about 450 feet to effect the necessary connection. The vein exposed in the course of driving referred to had been very irregular, pinching out at times, and at others showing a width of several feet. Due to this feature being almost identical with the experience in the level above, there had been rendered necessary several short crosscuts. It was satisfactory to note that no change in the country rock had been experienced at this depth, and, therefore, the whole of the conditions appeared to be quite favorable for their finding a continuance of the ore shoots in depth. They anticipated that the connection with the No. 3 shaft workings would be effected within the next three months. Later on they proposed to extend the drive west of the tunnel intersection, in order to get under any big shoot of ore worked in the vicinity of the No. 1 shaft. The lower workings in the latter section were situated about 800 feet above the horizon of the lower level tunnel. It was a source of satisfaction to note that, notwithstanding the unprecedented conditions that had prevailed in the last three years, the work of driving this tunnel a little over 2 miles in length was completed within the time estimated for it. That the cost anticipated had been exceeded was natural when the large increase in the price of all commodities was considered, but their greatest difficulty had been experienced in obtaining a sufficiency of labor, and often enough that labor had been anything but efficient.

The London office of the Camp Bird (Ltd.) issued the following circular:[2]

> It may be useful to recall that the tunnel intersected the Camp Bird lode almost exactly at the point predicted by our engineers. At the point of intersection no value was encountered, which is what was to be expected from the conditions existing in

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[1] Min. Mag. (London) Dec., 1918, p. 38 (adv. section) and p. 340. See also Min. and Sci. Press, Dec. 21, 1918, p. 842.

[2] Min. and Sci. Press, Mar. 29, 1919, pp. 436–437.

the old workings above this point. Having thus proved the existence of the lode, its exploration was at once undertaken by a drift east. At about 1,500 feet from the point of intersection a run of high-grade ore was encountered, which seems to correspond with the body of ore extracted from workings on the old ninth level above it. Further driving on the tunnel level disclosed a small body of ore, the value consisting largely of silver. After passing through these two runs of ore, the east drift was continued in low value till at about 1,950 feet from the point of intersection another run of ore of good value was entered, and from this point to the present face appearances are very encouraging. This last-named run of ore probably corresponds with the important body of ore (which yielded a profit of some £500,000) which was extracted from the No. 3 shaft workings at and above the old ninth level, this being some 450 feet above the present low-level tunnel. The manager has no hesitation in believing that the lode encountered—and driven upon for about 2,000 feet—from the tunnel is the true Camp Bird vein with known characteristics established in the old workings. The mineral hematite has made its appearance in the tunnel, and its presence seems to be an indicator of the existence of value in this section as it always was in the upper workings.

The directors conveyed to the manager their wish that connection should be made between the tunnel-level and the ninth level, by means of a raise (at the 1,500-foot point, where high value was found) simultaneously with pushing ahead of the east drift. He, however, has pointed out the difficulties, owing to insufficient ventilation, of doing this work on the two points at the same time, and further information is awaited hereon, with final decision of the manager as to the best policy. In the meantime exploratory work has been carried out by means of two raises about 30 feet apart in the neighborhood of the two runs of ore at the 1,500-foot point. These raises have already passed through 13 feet of good-grade ore, revealing a large vein, but the total width of the ore here is not yet determined. From the tunnel three crosscuts also are being put in 50 feet apart; notwithstanding this, the manager finds the results on the tunnel-level under the main No. 9 level ore shoot (about the present end of the drift) so encouraging that he strongly recommends exploration at this point. In a letter just received from the manager describing existing conditions above the tunnel-level he says: * * * vein conditions otherwise correspond with those on ninth level a little farther west, leading one to believe that probably the conditions existing in ninth level, at parallel 1,450, are to be repeated in this level; and it was east of this point that we had the best slope in the ninth level.

Uncompahgre district.—The Uncompahgre district produced in 1918 from 24 mines, 3,787 tons of ore, yielding $20,599 in gold, 124,790 ounces of silver, 19,449 pounds of copper, and 468,338 pounds of lead, with a total value of $183,445, as compared with $170,809 in 1917.

The copper matting plant at Ouray was idle. The American Nettie amalgamation-concentration mill, consisting of a 3½-foot Huntington mill, amalgamation plates, and Wilfley table, was operated part of the year on old dump and stope fillings, yielding amalgam bullion and gold-silver concentrates. Lead-silver ore direct to smelter was shipped from the Bachelor-Khedive mine and from the Calliope mine. Silver ore was shipped from the Newsboy mine, from the Pony Express, and from the Wedge mine. A considerable quantity of gold ore was shipped from the Bright Diamond mine. The remainder of the production from this district was made up of small lots or cars from the Black Girl, El Madhi, Float, Leadville, Maid of the Mist, Mineral Farm, Monarch, Paul, Rose, and Senorita.

PARK COUNTY.[1]

Mine production in Park County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.		Silver.[a]	Copper.	Lead.	Total value.
			Placer.	Deep.				
		Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	20	2,693	$5,451	$111.907	14,705	12,824	278,709	$156,945
1918	11	2,304	....	63,176	18,280	12,704	233,873	101,199
Increase or decrease, 1918	−9	−389	−5,451	−48,731	+3,575	−120	−44,836	−55,746

[a] Includes placer production.

Beaver Creek district.—No work was done on the placer deposits of this district.

Buckskin district.—Two small lots of ore were shipped to smelter from the J. G. Blaine mine and from the Paris mine. The Fanny Barrett mine was reopened in an effort to open deposits of manganese oxide ore.

Consolidated Montgomery district.—The Dolly Varden mine was under development by the Louisiana-Colorado Mining Co., which began development by a crosscut adit, built a concentration-flotation mill, and tested the mill with a small quantity of ore, with product as lead-silver concentrate. Several cars of silver ore were shipped from the Moose mine and a car of silver-lead ore from the Wheeler mine.

Fairplay district.—Testing and drilling of placer areas was done in this district by one of the Summit County dredging companies.

Freshwater district (*Guffey*).—Some development work was done in this district.

Hall Valley district.—A 60-ton table concentration-flotation mill was completed in 1918 at the Whale mine and much development work done. The mill was operated for several months, the product being a lead-silver concentrate.

Horseshoe district.—Several cars of silver ore were shipped from the Hill Top mine.

Lake George (*Pulver*) *district.*—Some development work was done in this district.

Mosquito district.—Several cars of lead-silver ore were shipped from the Hock Hocking mine. The new (in 1917) 40-ton concentration mill was not operated. The London mine,[2] at the head of Mosquito Creek, on the ridge betweem Alma and Leadville, continued to be a large producer of lead ore carrying a high content of gold.

Tarryall district.—The Fortune placers in this district were idle in 1918.

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[1] For discussion of geology see Patton, H. B., Hoskin, A. J., and Butler, G. M., Geology and ore deposits of the Alma district, Park County, Colo.: Colorado Geol. Survey Bull. 3, 1912.

[2] For discussion of geology see Moore, C. J., The London mine, Mosquito district, Colo.: Am. Inst. Min. Eng. Bull. 75, pp. 415–427, March, 1913.

PITKIN COUNTY.[1]

Mine production in Pitkin County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds*	*Pounds.*	*Pounds.*	
1917....................	11	124,824	$105	662,045	27,403	14,352,523	571,794	$1,845,751
1918....................	15	98,413	2	558,722	9,684	11,666,592	145,286	1,402,665
Increase or decrease, 1918.	+4	−26,411	−103	−103,323	−17,719	−2,685,931	−426,508	−443,086

Aspen (Roaring Forks) district.—At Aspen are located all the principal producing mines in Pitkin County, nearly all of which in 1918 were operated by the Smuggler Leasing Co. The Smuggler 360-ton concentration mill[2] was operated on low-grade silver-lead-zinc ores of the district, the product of which was lead-silver concentrates. A large quantity of lead-silver ore and much silver ore carrying only a small percentage of lead was shipped direct to smelters. Some lead-zinc sulphide and zinc carbonate ores were also shipped. Producing mines were the Aspen, Aspen Fraction, Bushwhacker, Della S. Durant, Free Silver, Millinee, Mineral Farm, Mollie Gibson, Pride of Aspen, and Spar. The Hunter Creek Leasing Co. also shipped its ore to the Smuggler mill and the Newman Mining & Leasing Co., operating the Newman group, shipped lead-silver ore to smelters and low-grade lead-silver ore to the Smuggler mill. The Hope Mining & Leasing Co., a local corporation continued to drive its crosscut adit to cut the Little Annie and other mines at depth. This adit at the end of 1918 was 8,146 feet of a proposed total of 9,500 feet. The Park Tunnel Mining & Milling Co. has driven 800 feet of a proposed 3,000-foot adit to reopen long idle properties in Tourtelotte Park. The Midnight Mining Co., driving an adit from Queens Gulch to connect with the Midnight shaft, has driven 3,000 feet of the proposed 5,200 feet.

Ashcroft (Columbia) district.—No production has been made in this district for many years.

Snowmass Creek district.—A shipment of copper-silver ore was made in 1918, from the Dixie Queen group, 12 miles from Snowmass station.

RIO GRANDE COUNTY.

(See also Conejos County.)

Summitville district.[3]—No work was done in this district in 1918.

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[1] For discussion of geology see Spurr, J. E., Geology of the Aspen mining district, Colo., with atlas: U. S. Geol. Survey Mon. 31, 260 pp., 1898.

[2] For description of mill see Anderson, C. E., Colorado Bur. Mines Thirteenth Bienn. Rept., for 1913–14, pp. 104–105, 1914.

[3] For discussion of geology see Patten, H. B., Geology and ore deposits of the Platoro-Summitville mining district, Colo.: Colorado Geol. Survey Bull. 13, 1917.

ROUTT COUNTY.[1]

Hahns Peak district.—No placer production was made from this district in 1918. At the Royal Flush group, near Columbine, installation of larger mine equipment, widening of the adit to make clearance for locomotive haulage, and some development work was done. Several hundred tons of ore were treated at the 30-ton (per 8 hour shift) concentration mill in experimental work in testing the mill. The concentrates carried gold and silver in commercial quantities. A car of silver ore was shipped from the Minnie D mine. A small quantity of bullion was shipped from the Mahler mine. A car of lead-silver ore was shipped from the Olson mine.

Slater district.—Assessment work only was done in this district in 1918.

Yarmony district.—No work was done at the prospects of copper carbonate in sandstone, for the treatment of which a leaching plant was built in 1915 and operated for a short time in 1916.

SAGUACHE COUNTY.

Mine production in Saguache County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1917	26	4,224	$10,350	76,016	144,978	310,686	$139,285
1918	10	1,716	2,553	89,510	96,866	108,253	123,675
Increase or decrease, 1918	−16	−2,508	−7,797	+13,494	−48,112	−202,433	−15,610

Baca Grant (*Crestone*) *district.*—Some assessment work was done in this district.

Baca Grant (*Music or Liberty*) *district.*—No work was done in this district.

Cochetopa district.—No work was done in this district.

Crystal Hill district.—A car of silver ore was shipped from the Esperanza mine.

Embargo district.—No work was done in this district.

Kerber Creek (*Bonanza*) *district.*[2]—The production of this district, from which came nearly all the production of the county in 1918, was only slightly less in value than that for 1917. A large quantity of copper-silver ore and much straight silver ore was shipped from the Cocomongo mine. Lead-silver ore was shipped from the Antoro, Brighton, Cuba, Erie, Memphis, and Michigan-Paragon mines. No ore was shipped from the Rawley mine. On this property there is a 100-ton concentration plant (built 1903) consisting of jigs and tables, which has not been operated owing perhaps to the lack of water. In the suggested plans for the operation of this property it is proposed to build a new mill at Shirley, on the railroad, 6½ miles from the mine.

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[1] For discussion of geology see George, R. D., and Crawford, R. D., The Hahns Peak region, Routt County Colo.: Colorado Geol. Survey First Rept. for 1908, pp. 189-229, 1909; Gale, H. S., The Hahns Peak gold field: U. S. Geol. Survey Bull. 285, pp. 28-34, 1906; White, C. A., On the geology and physiography of a portion of northwestern Colorado and adjacent parts of Utah and Wyoming: U. S. Geol. Survey Ninth Ann. Rept., p. 691, 1889.

[2] Patton, H. B., Geology and ore deposits of the Bonanza district, Saguache County, Colo.: Colorado Geol. Survey Bull. 9, 1916.

SAN JUAN COUNTY.[1]

Mine production in San Juan County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	46	145,685	$318,006	658,261	1,665,923	10,515,585	3,270,500	$2,553,137
1918	37	132,927	257,011	477,322	1,120,178	9,485,775	3,410,308	1,994,845
Increase or decrease, 1918	−9	−12,758	−60,995	−180,939	−545,745	−1,029,760	+139,808	−558,292

Animas district (including the mines in the vicinity of Silverton and south and east of Animas River from Silverton to Middleton).—The Animas district in 1918 produced 69,545 tons of ore, yielding $180,042 in gold, 298,969 ounces of silver, 711,716 pounds of copper, and 5,751,648 pounds of lead, with a total value of $1,063,172, as compared with $1,573,409 in 1917 and with $881,884 in 1916.

There were 28 producing mines in the district in 1918, a decrease of 7 mines. The 6 mines that produced the greater part of the yield were the Dives, Highland Mary, Iowa-Gold Tiger, Mayflower, Pride of the West, and Silver Lake. Siliceous lead-silver sulphide ore was shipped from the Dives mine direct to the Durango smelter. Both smelting lead-silver ore and silver milling ore carrying a small quantity of lead was shipped during the year from the Highland Mary, the product from the mill being a lead-silver concentrate. Siliceous lead-silver-gold sulphide ore from the Iowa-Gold Tiger was milled at the Iowa-Tiger concentration-flotation mill. The Iowa-Tiger mill was also used as a custom plant to treat a large quantity of ore from the Mayflower mine, the product being lead-copper-silver-gold concentrates. The Pride of the West Mining Co., operating the Pride of the West mine and Green Mountain mines and Green Mountain mill under lease and bond, sent a large quantity of lead-silver sulphide ore to the mill until the time of closing in October. The mill is equipped with crusher, classifiers, 6 double-compartment jigs, 8 Card tables and 1 Wilfley table, and 2 Hyde flotation machines. Lessees on the Silver Lake mines shipped lead-silver ore to Durango and lead-copper-silver sulphide ores to the Silver Lake mill and to the North Star mill. The Mears-Wilfley concentration-flotation mill also continued to be operated on old tailings from the Silver Lake mill tailings pond, yielding a copper-silver-gold concentrate.

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[1] For discussion of geology, see Cross, Whitman, Howe, Ernest, and Ransome, F. L., U. S. Geol. Survey Geol. Atlas, Silverton folio (No. 120), 1905; Emmons, W. H., Ore deposits of Bear Creek, near Silverton, Colo.: U. S. Geol. Survey Bull. 285, pp. 25-27, 1906; Ransome, F. L., A report on the economic geology of the Silverton quadrangle, Colo.: U. S. Geol. Survey Bull. 182, pp. 1-265, 1901.

Experimentation work was carried on at the Caledonia mill. Copper-silver ore was shipped from the Copper Queen and from the Emerald mine. From the Champion No. 2 mine mixed sulphide ore was milled at the North Star mill and copper ore was shipped to Durango. Lead-silver-gold ore was shipped from the Hercules mine by the Dora Consolidated Mining & Milling Co. The Hamlet concentration mill (built 1916) was operated for seven months during 1918, the product being lead-copper-silver concentrates. Copper-silver ore was shipped to Durango from the Champion No. 1 mine. Various small lots of ore were shipped from other properties and a considerable quantity of bullion bars from various properties reached the Mint during the year.

Eureka district (north of Silverton, including Chattanooga, Animas Forks, Eureka, and Red Mountain).—This district in 1918 produced 63,382 tons of ore, carrying $76,969 in gold, 178,353 ounces of silver, 408,462 pounds of copper, 3,734,127 pounds of lead, and 3,410,308 pounds of zinc, with a total value of $931,673, as compared with $979,728 in 1917, and with $1,324,811 in 1916.

Copper-silver ore was shipped from the American Queen mine. Copper-silver-gold ore was shipped from the Congress mine and a car of copper-silver ore from the Henrietta mine, to Durango. Lead-silver ore was shipped from the Kansas City, from the Mountain Queen, from the St. Paul, and from the Silva Queen (Telescope) mine. A car of lead-zinc concentrates from the Ledge mine was produced at the North Star mill during the year. The Gold King mine and mill was taken over by a new company, the Gold King Extension Mines Co., but no output was made in 1918.

The new Sunnyside 600-ton flotation mill (built in 1917–18) was operated for 8 months, averaging 300 tons a day during that time. The product was lead-silver-gold concentrates shipped to Durango and lead-zinc concentrates also carrying much silver and some gold to zinc retort plants.

SAN MIGUEL COUNTY.[1]

Mine production in San Miguel County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	20	389,293	$2,009,961	779,364	920,425	6,205,326	1,810,245	$3,621,736
1918	27	374,134	2,127,634	836,570	992,814	6,044,085	797,648	3,711,145
Increase or decrease, 1918	+7	−15,159	+117,673	+57,206	+72,389	−161,241	−1,012,597	+89,409

Upper San Miguel district.—The Upper San Miguel district in 1918 produced 371,073 tons of ore, carrying $2,123,123 in gold, 796,263 ounces of silver, 942,409 pounds of copper, 5,605,183 pounds of lead, and 790,637 pounds of zinc, with a total value of $3,622,077, as compared with $3,586,393 in 1917 and with $3,294,393 in 1916.

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[1] For discussion of geology, see Purington, C. W., Preliminary report on the mining industries of the Telluride quadrangle, Colo.: U. S. Geol. Survey Eighteenth Ann. Rept., pt. 3, pp. 745–850, 1898; Cross, Whitman, and Purington, C. W., U. S. Geol. Survey Geol. Atlas, Telluride folio (No. 57), 1899; Hess, F. L., Notes on the vanadium deposits near Placerville, Colo.: U. S. Geol. Survey Bull. 530, pp. 142–156, 1912.

The three large companies, the Liberty Bell, the Smuggler Union, and the Tomboy, continued to furnish the greater part of the total output, which also includes a large quantity of ore treated at the Smuggler Union mill from the Black Bear mine. The Smuggler Union mill also treated a large quantity of ore from the Humboldt mine (in Ouray County), credit for which is given to Ouray County.

The Belmont-Wagner Mining Co., which took over the Alta mines in 1917 and did much development work at the mine and reconstruction of the mill to adapt it to the flotation process, continued such work in 1918, and operated the new mill for two months, August and September. The entire plant was remodeled and the 30 stamps discarded and two No. 64½ Marcy mills installed. The primary crushing is done in a Gates gyratory crusher, followed by grinding in Marcy mills, operated in closed circuit with Dorr classifiers, flotation in Jones-Belmont machines; sodium sulphide is used for sulphidizing partly oxidized ores. The mill was shut down owing to lack of labor until May, 1919. The mines of this company are the Alta, in Gold King Basin, and the St. Louis, in Turkey Creek Basin. The ores are base, siliceous, and partly oxidized, containing considerable barite, but zinc only in slight quantities. The properties are opened by adits, the St. Louis adit being 3,500 feet in length and the Alta adit 4,900 feet. Other levels, raises, and crosscuts make a total of 18,000 to 20,000 feet of development.

At the Cimarron mine 10 stamps of the 30-stamp concentration mill (built in 1890) were operated on dump ores.

The Black Bear 20-stamp amalgamation-concentration mill (built in 1906, and operated in 1907 and 1910) was idle on account of lack of water, but a large quantity of complex galena-pyrite-chalcopyrite-sphalerite ore from the mine was steadily treated at a fixed rate at the Smuggler Union mill, at Pandora. The mill equipment consists of 30 stamps to Aikins classifiers, overflow to Wilfley tables and oversize to Hardinge ball mill, thence to above tables making lead, iron, and zinc concentrates; all table tailings go to Janney M. A. flotation machines.

The Smuggler Union 60-stamp mill with amalgamation and table and vanner concentration equipment and flotation machines was operated continuously 24 hours per day on ores from the Smuggler Union properties and from the Humboldt mine (Ouray County) and from the Black Bear mine. Cyanidation has been abandoned at this mill.

The Liberty Bell 80-stamp concentration and cyanidation mill was operated 363 days. The ore is crushed in cyanide solution, ground in tube mills, classified, and concentrated on tables. Both concentrates and tailings are cyanided by agitation and filtering. The mill was modified by the addition of 4 extra Wilfley tables, 2 agitators, and classifiers to make the cyanide treatment of concentrate more perfect. No concentrate was shipped to smelters after May, 1918.

The eighteenth annual report of the Liberty Bell Gold Mining Co. for the year ended September 30, 1918 (dated February 6, 1919), says:

The most conspicuous features of the operations of the past year are the high grade of the ore milled and the high costs of operating. The coincidence of the two was not only very remarkable but most fortunate, for, had the ore remained anywhere near the quality of preceding years, operations would have been conducted at a great loss and a suspension might have been necessary.

The high costs as well as the small tonnage mined were partly due to war conditions, with their high prices of materials and scarcity and poor quality of labor, and partly due to the facts that the vein mined was very narrow, very hard, and in a remote and inaccessible part of the mine. This is evidenced by the fact that, with a tonnage of only three-fifths of the preceding year the total mining cost was over 25 per cent greater and the area stoped was practically the same. The item of general expense, it may be noted, was just twice the amount of the preceding year, but this is attributable almost entirely, to the increase in taxes, royalties and employees' fund allotments which aggregated about $58,000. The milling costs remained about the same total, as it took the full capacity of the mill to handle this smaller tonnage of more refractory ore.

A noteworthy feature of the report is the excellent recovery, where it appears that 96 per cent of the total value was saved and the tailings from ore of over $13.00 per ton were reduced to only 60 cents.

Attention is called particularly to the estimate of ore reserves and prospective profit. The conclusion to be drawn is that about one more year will probably bring the operations of the Liberty Bell mine to a conclusion.

The profit balance for the year, with the addition of the depreciation allowance of some $33,000, was about $368,000. During the year dividends were paid of 58 per cent, aggregating $387,310.

Summary of operating receipts and expenses, Liberty Bell mine, 1917–1918.

		Totals.		Rate per ton.		
				1918	1917	1899–1918.
Receipts:						
Ore proceeds (90,700 tons)			$1,153,042.82	$12.71	$5.92	$6.55
Stamp bullion						2.63
Cyanide products		$1,084,700.08		11.96	5.52	3.22
Concentrates		68,342.74		.75	.40	.65
Concentrate cyanide bullion						.04
Slag						.01
Tram receipts	$2,854.10					
Rental receipts	3,469.05					
Commissary profit	4,434.22					
Interest and dividends	17,457.01	28,214.38				
Less loss on boarding house	14,231.93					
Less loss on investments	18,502.51	32,734.44	Dr. 4,520.06	Dr. .05	.14	.16
Total receipts			1,148,522.76			
Average receipts per ton milled				12.66	6.06	6.71
Expenses:						
General expenses (90,700 tons)			118,155.90	1.30	0.41	0.63
Mining (91,300 tons)			394,223.08	4.32	2.18	2.31
Operating		365,502.98		4.00	1.90	
Development work (3,021 feet)		28,720.10		.32	.28	
Tramming (91,300 tons)			17,082.54	.19	.17	.24
Milling (90,700 tons)			254,046.60	2.80	1.67	1.64
Treatment and shipping costs			29,945.77	.33	.23	.26
Stamp bullion						
Concentrates (2,349 tons)		23,877.54		10.17	[a] 8.13	
Cyanide bullion (226,757 ounces)		6,068.23		.03	[b] .02	
Total operating expenses			813,453.89			
Average cost per ton milled				8.97	4.66	5.08
Balance profit			335,068.87			
Per ton milled, profit				3.69	1.40	1.63

[a] Per ton of concentrates.

[b] Per ounce of bullion.

Summary of ore proceeds and expenses, Liberty Bell mine, 1917–18.

	1918	1917	1899–1918
Stamp bullion, gross value	......	......	$5,633,402.93
Concentrates, gross value	$68,342.74	$57,815.70	1,399,989.59
Concentrate cyanide bullion, gross value	......	......	90,019.70
Cyanide bullion, gross value	1,084,700.08	789,543.96	6,784,474.84
Cyanide precipitate, gross value	......	......	121,153.01
Slag	......	......	14,853.15
Total ore proceeds	1,153,042.82	847,359.66	14,043,893.22
Total expenses (less boarding house and other like receipts)	817,973.95	645,841.99	10,552,056.24
Profit balances	335,068.87	201,517.67	3,491,836.98
Percentage profit to total ore proceeds	......	......	24.86
Expended on mining property and construction (less depreciation already charged to expense) about	33,923.19 (credit.)	33,816.68 (credit.)	146,174.49

Ore milled, 90,700 tons; gross values per dry ton milled, and percentages, Liberty Bell mine, 1917–18.

Recovered.	1918						1917		1899–1918	
	Gold.		Silver.		Value.		Value.		Value.	
	Fine ounces.	*Per cent.*	*Fine ounces.*	*Per cent.*		*Per cent.*		*Per cent.*		*Per cent.*
In stamp bullion	......	......	......	......	......	......	......	......	$2.63	34
In concentrates	$0.026	5	$0.247	10	$0.75	6	$0.40	6	.65	8
In concentrate cyanide bullion	......	......	......	......	......	......	......	......	.04	1
In cyanide products	.491	93	1.942	75	11.96	90	5.52	83	3.23	41
Total recovery	.517	98	2.189	85	12.71	96	5.92	89	6.55	84
Lost in tailings	.012	2	.376	15	.60	4	.76	11	1.29	16
Total contents	.529	100	2.565	100	13.31	100	6.68	100	7.84	100

The Tomboy 60-stamp, 400-ton amalgamation-concentration mill, and 400-ton cyanidation plant was operated continuously during 1918 on ores from the Argentine and Montana mines. Early in 1919 it was decided to build at once an oil-flotation plant to cost $150,000. It is estimated that at least $1 per ton more can be saved by this process. This company has operated the Tomboy property since 1899.

The annual report of the Tomboy Gold Mines Co. (Ltd.), for the year ended June 30, 1918,[1] shows

> that 151,028 tons of ore were milled, yielding amalgam bullion worth $306,000 and concentrates worth $662,000. Tailings to the amount of 129,000 tons were cyanided, yielding bullion worth $168,000. A marked shortage and inefficiency of labor has increased costs materially and caused a reduction of ore reserves. Continuous tests were made from February to July with milling ore, so as to establish a reliable comparison between flotation and the present methods of treatment. The results confirmed the advantage of the flotation process and it will make available large tonnages of developed low-grade ore on the property. However, under the present conditions of the labor and materials market, installation will be postponed.

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[1] Chem. and Met. Eng., Feb. 15, 1919, p. 149.

Costs, per ton, at the Tomboy mine.[1]

Mining and development	$2.51
Milling	.70
Concentrate expense, including transport to rail	.63
Water supply	.09
Assay office	.05
Cyaniding	.91
General	.33
Taxes and insurance	.36
	5.58

Two dividends amounting to $110,000 were distributed. In the Argentine mine, 568 feet of work was done on the east faces of the 1,900 and 2,100 foot levels. In 395 feet of the upper levels, 5 feet of ore averaged $3.62 in gold and silver, 4.45 per cent lead, 6.89 per cent zinc, and 0.8 per cent copper. At 2,100-foot depth, 111 feet driven on 4.2 feet of ore assay $2.83 in gold and silver, 2.13 per cent lead, 4.42 per cent zinc and 0.95 per cent copper. Reserves are 130,000 tons of which 100,000 tons are broken in the stopes.

In the Montana mine exploration covered only 3,346 feet, much lower than usual owing to the labor supply. About 1,500 feet of this was done on the Virginius vein, 400 feet being through the Robson claim of the Camp Bird Co. Within the Tomboy boundaries this body is 900 feet long, assaying $9 in gold and silver, across 3 feet. Other workings show $15 across 6 feet and $12 silver and 5.9 per cent lead over 4 feet. Reserves are estimated at 350,000 tons, exclusive of the Sidney and Virginius. Of this, 200,000 tons are broken.[2]

The Lewis mine was reopened, development at the end of the year being a 650-foot vertical shaft, a 2,800-foot adit, and 2,600 feet of drifts, of which drifts 450 feet were driven in 1918. The mill was remodeled into a 75-ton crushing and grinding plant and a 30-ton flotation plant and was operated three months only.

Iron Springs (Ames and Ophir) district.—The Iron Springs district in 1918 produced 3,048 tons of ore, carrying $4,391 in gold, 40,113 ounces of silver, 50,405 pounds of copper, 438,606 pounds of lead, and 7,011 pounds of zinc, with a total value of $88,733, as compared with $35,343 in 1917. The principal producing mine was the Carbonero, from which lead, lead-copper, and lead-zinc ore was shipped. Lessees on the Butterfly-Terrible mine and amalgamation-concentration mill operated the mill for a short time. The Carribeau concentration mill was operated for a short period, the product being lead-silver concentrates. Several cars of lead-silver ore were shipped from the Favorite mine, and a car of lead-silver ore from the Silver Bell. Lessees on the Suffolk mine produced about 100 tons of ore, which was milled at the Suffolk amalgamation-concentration mill. Several cars of lead-silver ore were shipped from the San Bernardo mine.

Lower San Miguel district (Sawpit and Placerville).—A car of gold-silver ore was shipped from the Baron Tunnel property.

Mount Wilson district.—Some development and assessment work was done in the Mount Wilson district but no ores were sold.

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[1] Min. and Sci. Press., Dec. 14, 1918, p. 782.
[2] Idem, Dec. 21, 1918, p. 842.

SUMMIT COUNTY.

Mine production in Summit County, Colo., in 1917 and 1918.

Year.	Number of producing mines.	Ore.	Gold.		Silver.[a]	Copper.	Lead.	Zinc.	Total value.
			Placer.	Deep.					
		Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1917	51	66,768	$540,951	$62,486	175,699	25,033	915,535	19,868,814	$2,860,402
1918	36	58,185	431,023	36,116	117,326	13,206	777,338	15,696,264	2,071,278
Decrease, 1918	15	8,583	109,928	26,370	58,373	11,827	138,197	4,172,550	789,124

[a] Includes placer production.

The value of the production of Summit County in 1918 dropped back to slightly above the production in 1915. Dredges[1] and other placer operations yielded $431,023 in gold and 5,353 ounces of silver, valued at $5,353, a total of $436,376, as against $540,951 in gold and 6,636 ounces of silver in 1917, against $579,050 in gold and 7,292 ounces of silver in 1916, and $607,195 in gold and 7,487 ounces of silver in 1915.

The principal placer-producing district in Colorado is near Breckenridge, Summit County. This county is also one of the three principal zinc-producing counties, being exceeded only by Lake and Eagle counties.

Breckenridge district.[2]—The Breckenridge district includes the Bevan, Minnesota, and Union districts and includes all the mines (near Breckenridge) on French Gulch and on Blue and Swan rivers and all the placers in the county. The value of the total output of gold, silver, copper, lead, and zinc from both deep and placer mines was $1,926,636, or 93 per cent of the county yield, and a decrease in 1918 of $696,958, following an increase in 1917 of $66,787, an increase in 1916 of $760,170, and an increase in 1915 of $814,308.

The Wellington mine continued to be the principal producing property in the district. The 110-ton wet-concentration mill, with rolls, jigs, and tables, and the 100-ton roasting magnetic separation plant[3] with rolls, roasters, and magnetic separation machines for treatment of the zinc-iron middling product, were operated continuously, except during October and November, when, owing to the influenza epidemic, No. 1 mill was run only two shifts per day instead of three. In addition, a considerable quantity of high-grade zinc ore was shipped direct to smelters. The annual report of the Wellington Mines Co. for the fiscal year ended November 30, 1918 (dated December 14, 1918), says:

> During the year 2,365 feet of drifts and crosscuts and 975 feet of raises were driven. The Wellington vein was opened on the sixth level 500 feet west of the shaft and drifted on for 300 feet. The vein on this drift carries ore of good grade. Ore extraction for the year was again confined to the Great Northern vein, a total of 40,242 tons.

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[1] See Revett, B. S., Gold dredging: Colorado Bur. Mines Thirteenth Bienn. Rept., for 1913–14, pp. 128–131, 1914.

[2] For discussion of the geology of the district see Ransome, F. L., Geology and ore deposits of the Breckenridge district, Colo.: U. S. Geol. Survey Prof. Paper 75, 1911.

[3] For description of magnetic plant see Parmalee, H. C., Zinc ore dressing in Colorado: Met. and Chem. Eng., September, 1912, pp. 525–528. For description of mills see Henderson, R. M., Colorado Bur. Mines Thirteenth Bienn. Rept., for 1913–14, pp. 106–110, 1914.

being mined. There were 947 tons of 45.7 per cent zinc shipped direct to the smelter and 39,295 tons of 25 per cent zinc sent to the mills. There were 39,295 tons of ore carrying 25 per cent zinc crushed, and there were produced 16,631 tons of 49.6 per cent zinc concentrates and 184 tons of lead concentrates assaying 25.7 ounces of silver and 36 per cent lead. There were 2,681 tons of iron tailings from No. 2 mill shipped to the smelter.

* * * An electric hoist was bought with which to equip the Oro shaft for the purpose of developing the Siam vein. Two new concentrating tables were added to the equipment of No. 1 mill. * * *

The Siam vein should be opened up during the ensuing year and if miners are available some of the other veins in the property may be developed to good advantage.

A car of silver ore was shipped from the Brooks-Snyder mine. Several cars of lead-gold ore were shipped from the Dunkin, but no high-grade pocket gold for which this mine is known was shipped in 1918. Lead-silver ore was shipped from the Ella-Minnie, June Bug, and Iron Mask mines. Silver ore was shipped from the Minnie B mine, and silver-copper ore from the Molly B. Development work was continued all year at the Jessie, and the 20-stamp amalgamation-concentration mill was operated from June to October.

Five dredges were in operation in the district in 1918. A new dredge built in 1917–18 by the Powder River Gold Dredging Co. was operated during eight months of the year. All four of the old dredges were also operated steadily. The report of the Tonopah Placers Co. (subsidiary of the Tonopah Mining Co.) for the year ended December 31, 1918, says of its three dredges:

At the close of the season of 1917, the ground upon which No. 1 dredge had been working had all been dredged, and it was necessary to move the dredge to the Magnum Bonum placer, which is one of the best pieces of placer ground owned by this company. The ground between where the No. 1 dredge then was and the Magnum Bonum placer was owned by other parties, and it was necessary to secure the privilege of passing the dredge through this intervening ground. Most of the season of 1918 was spent in dredging through this intervening ground; therefore, with No. 1 dredge on the Magnum Bonum placer and good ground ahead, that will take at least four years to dredge, the prospects for the future earnings of this dredge are very encouraging.

Dredge No. 2 was operating on ground belonging to the Farncomb Hill Gold Dredging Co., under a contract by which the Tonopah Placers Co. receives one-half of the net profits. This ground proving to be of lower value than ground dredged in the previous years materially reduced the earnings of this dredge.

Dredge No. 3 reached the end of our property in the direction it was going and was turned back. This dredge is now on the edge of ground where the drilling shows good values to exist, with at least two years' work ahead on this ground.

Production and income statement of Tonopah Placers Co. for the year 1918.

Gross value of bullion shipped to mint		$282,973.83
Cost of operations		332,902.26
Loss in operations		49,928.43
Other income:		
Earnings from electric-lighting plant	$2,031.41	
Storehouse supplies	6,152.21	
Interest on bank balance	447.44	
Miscellaneous	1,374.33	
		10,005.39
		39,923.04

Charges against profit and loss account:	
Depletion of ore—5 per cent on cost of property and 10 per cent on plant and equipment for year 1918	$99,818.27
Net loss for year 1918	139,741.31
Surplus, Dec. 31, 1917	219,525.46
Surplus, Dec. 31, 1918	79,784.15
Cubic yards dredged	3,267,307
Gold produced, ounces	13,564.99
Silver produced, ounces	3,345.29
Value per yard	$0.086

Two of the Tonopah Co.'s dredges are of the Bucyrus open-connected type, with buckets of a capacity of 9½ cubic feet; the other dredge is of the double-lift, open-connected type, with buckets of a capacity of 9 cubic feet. The French Gulch Dredging Co. (or Reiling) dredge is of the Bucyrus type with buckets of a capacity of 5 cubic feet.

Bullion from the Tonopah Co.'s dredges averaged in fineness 0.788 gold and 0.194 silver; that from the French Gulch Co.'s dredge averaged 0.876 gold and 0.118 silver; and that from the Powder River Co.'s dredge averaged 0.757 gold and 0.193 silver.

No hydraulicking and very little sluicing was done in the district in 1918.

Consolidated Tenmile (Frisco, Kokomo, and Robinson) district.[1]—This district in 1918 produced from 14 mines 12,190 tons of ore, carrying $15,916 in gold, 75,562 ounces of silver, 11,453 pounds of copper, 315,873 pounds of lead, and 98,396 pounds of zinc, with a total value of $125,688, as compared with $210,084 in 1917 and with $80,880 in 1916.

The Elk Mountain Mines Co., operating the Wilfley mines, at Kokomo, completed a 100-ton concentration mill and operated it from July to December, the product being a lead-silver-gold concentrate. From January to July, regular shipments of pyritic silver ore were made from the Michigan mine, at Kokomo. From the Silver Queen mine (Golden Queen claim), at Kokomo, a very considerable quantity of silver ore was shipped during the year. There was a general clean-up of ores lying in and about the Robinson mill, and later the machinery in the mill was removed. The Silver Edge Mining Co. shipped a considerable quantity of silver ore from the Iron Mask mine.

At Frisco the Excelsior 20-ton amalgamation-concentration mill was operated for several months, and a shipment of lead-silver ore was made from the King Solomon tunnel property.

Montezuma district.[2]—This district in 1918, from 6 mines, produced 1,760 tons of ore, carrying $164 in gold, 7,449 ounces of silver, 737 pounds of copper, and 157,169 pounds of lead, with a total value of $18,954, as compared with $26,724 in 1917, and with $103,490 in 1916. The St. John 100-ton mill, with crushers, tube mills, classifiers, jigs, Wilfley tables, and flotation machines, was operated three months only, with product as lead-silver concentrate. No development work was done at the mine in 1918. This mine is opened by an 1,800-foot adit, a 600-foot shaft, and 5,000 feet of drifts. Several cars of lead-silver concentrates were the product from the treatment of ore from the Waterloo mine. A car of lead-silver ore was shipped from the Pennsylvania mine. Several cars of lead-silver ore were shipped from the Quail mine.

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[1] For discussion of geology see Emmons, S. F., U. S. Geol. Survey Geol. Atlas, Tenmile district folio (No. 48), 1898.

[2] For discussion of geology see Patton, H. B., The Montezuma mining district of Summit County, Colo.: Colorado Geol. Survey First Rept., for 1908, pp. 104-144, 1909.

TELLER COUNTY.

CRIPPLE CREEK DISTRICT.[1]

Mine production in Cripple Creek district, Colo., in 1917 and 1918.

Year.	Number of produc- mines.	Ore.	Gold.	Silver.		Total value.
				Quantity.	Value.	
		Short tons.		*Fine ounces.*		
1917	63	1,084,656	$10,394,847	64,568	$53,204	$10,448,051
1918	57	936,326	8,119,747	50,665	50,665	8,170,412
Decrease, 1918	6	148,330	2,275,100	13,903	2,539	2,277,639

In 1918 there were recovered in the Cripple Creek district by mills and smelters from crude ore and dump ore, from slags, slimes, and "clean-ups" of mills, from stolen bullion and ore, 392,792.76 fine ounces of gold, valued at $8,119,747.

CRIPPLE CREEK DRAINAGE OR ROOSEVELT TUNNEL.

The Roosevelt drainage tunnel, work on which was commenced 11 years ago, was completed during the year 1918. The end of the tunnel is located about the middle of the northerly part of the Portland Gold Mining Co.'s property and is 24,255 feet from portal to heading. During the year a branch tunnel was completed from the main Roosevelt tunnel to a connection with the Portland No. 2 shaft at a depth of 2,131 feet from the surface.

MILLS AT COLORADO SPRINGS.

The Golden Cycle mill, a roast-cyanide (with subsidiary amalgamation) plant[2] of 1,200 tons daily capacity, was operated steadily throughout the year 1918, notwithstanding high costs for both materials and labor and the difficulty of obtaining labor. The Portland 400-ton roast-cyanide concentration mill ceased operations March 31, 1918, so far as the treatment of ore was concerned. The production of high-grade ores in the Cripple Creek district had fallen off to such an extent by reason of war conditions that it was impossible to operate at a profit both of the reduction plants at Colorado Springs. As the Portland mill was the smaller of the two, it was decided to discontinue its operation, and to have the Portland high-grade ores treated at the Golden Cycle plant.

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[1] For discussion of geology see Lindgren, Waldemar, and Ransome, F. L., Geology and ore deposits of the Cripple Creek district, Colo.: U. S. Geol. Survey Prof. Paper 54, 1906.

[2] For description see Milliken, J. T., Colorado Bur. Mines Thirteenth Bienn. Rept. for 1913-14, pp. 73-74, 1914.

Important experimental work was carried on at the Portland Colorado Springs plant during the last nine months of the year, by representatives of the Federal Bureau of Mines, in an endeavor to develop a process for extracting potash from the tailings dumps. It has been discovered that these tailings contain 7 per cent of potash, or 140 pounds to the ton. There are 2,000,000 tons in the tailing dump of the Portland Co., a larger quantity in the tailing dump of the Golden Cycle, and a large quantity in the dump of the abandoned and dismantled plants of the U. S. Reduction & Refining Co.

At the Colorado meeting of the American Institute of Mining Engineers, at Colorado Springs, September 2–6, 1918, the Golden Cycle Mining & Reduction Co. issued a pamphlet describing its process as follows:

The Golden Cycle mill is treating Cripple Creek ore exclusively, which consists of sulpho-tellurides with practically no base metals.

The ore is classified into two classes according to their lime contents.

Class "A" ore contains not more than 2 per cent CaO and comprises about 66 per cent of the total.

Analysis of class "A" ore.

	Per cent.
Insoluble	86. 70
Al_2O_3	2. 30
Fe	3. 26
CaO	1. 57
S	1. 79
MgO	. 21
Ignition loss	3. 20
	99. 03

Analysis of class "B" ore.

	Per cent.
Insoluble	75. 90
Al_2O_3	2. 30
Fe	3. 48
CaO	5. 12
S	1. 80
MgO	1. 08
Ignition loss	6. 50
	97. 28

The ore is transported to the mill in standard railroad cars, the distance being 48 miles.

It is unloaded into receiving bins where it is run through Blake crushers, coarse rolls, and automatic Vezin sample cutters, thence by belt conveyors to the storage bins.

To insure proper roasting, the different classes of ore are kept separate in storage bins, holding 5,000 tons each.

Ore is drawn from the storage bins to Schmidt kominuters having slotted screens $\frac{5}{32}$ by $\frac{1}{2}$ inch slots, which gives a product with the following analysis:

	Per cent.
Plus $\frac{5}{32}$ inch	1. 1
Plus $\frac{1}{8}$-inch	2. 4
Plus 10 mesh	16. 6
Plus 20 mesh	26. 2
Plus 30 mesh	10. 2
Plus 40 mesh	7. 6
Plus 60 mesh	9. 8
Plus 80 mesh	1. 2
Plus 100 mesh	3. 0
Plus 150 mesh	3. 9
Plus 200 mesh	4. 4
Minus 200 mesh	3. 6

The ore is then roasted in nine Edwards duplex roasters using gas-producing fire boxes fired with lignite coal.

Capacity of roasters.—Class A ore, 100 to 150 tons per 24 hours; class B ore, 80 to 100 tons per 24 hours. Limit of soluble sulphur contents: Class A ore, 0.10 per cent; class B ore, 0.15 per cent.

Fine grinding is accomplished by seven Evans-Waddel 6-foot Chilean mills with cyanide solution, the product passing over blanket concentrator tables to recover the coarse gold. The pulp is then introduced into Dorr bowl classifiers, the sands going to leaching tanks and the slimes to Dorr thickeners and agitators, thence to Moore type vacuum filters.

The higher grade solutions are precipitated by the means of zinc shavings; for the low-grade final wash solutions zinc dust is used.

Before precipitating the gold from the solution the air is removed by means of the Crowe vacuum system.

The precipitates are reduced to bullion in four Case oil burning tilting furnaces.

Electric power is used throughout the mill, power being purchased on a maximum demand and current consumed basis.

Mill statistics for 1917.—Total tonnage treated, 361,000; gross value, $7,332,000.

MILLS IN THE CRIPPLE CREEK DISTRICT.

The Portland Co.'s Victor cyanide-concentration mill was closed on July 30, 1918, on account of the impossibility of procuring labor sufficient to supply the quantity of low-grade ore necessary for economical operation of both this mill and the Portland Co.'s Independence mill. Much of the machinery from the Victor mill was moved during the year to the Independence mill, and eventually all of the machinery will be transferred, thus ultimately combining all the ore-reduction operations at the Independence mill.

The Independence cyanide-concentration mill treated a considerable quantity of low-grade ore during 1918. and although the percentage of extraction was good the profits realized were disappointing, largely owing to war conditions. Almost without exception, every improvement devised to reduce costs and every economy instituted during the year was immediately offset by some increase in the cost of labor or of some chemical or commodity entering into the extraction of gold. The Independence mill has a coarse crushing and sampling capacity of 3,000 tons of ore daily and a fine crushing capacity of 1,250 tons a day. During 1918 these two mills treated 522,756 tons of ore containing gold of a gross value of $1,071,924.

The Vindicator Consolidated Mining Co. in its annual report ending December 31, 1918 (dated Feb. 10, 1919), says of its washing and concentration mill:

> After a considerable period of experimentation it was decided to institute radical changes in the method of dressing ore preparatory to shipment. The experimental work indicated that of the tonnage which was being shipped to the mill at Colorado Springs for treatment there was a considerable percentage on which freight and treatment charges were in excess of the value of the ore.
>
> Briefly, the practice is to eliminate from the primary shipping product all material which will not market at a profit. All this low-grade material is again mechanically handled to eliminate all material which will not pay to treat in the flotation plant.
>
> All rejects from the ore-dressing operations and Cycle shaft ore house are delivered to the flotation plant, where they are screened and all coarse waste rejected and the residue sent to the flotation plant crusher.
>
> During the year 1918 there were sent to the flotation plant from all sources 222,626 tons of ore, of an average value of $2.13 per ton. Of this, 176,623 tons, of an average of $1.42 per ton, were rejected by screening, and 46,003 tons of an average assay value of $4.18 per ton were sent to the flotation plant crusher. There were shipped from the flotation plant 6,029 tons of flotation concentrates, with a gross value of $206,255 and a net value after marketing charges of $171,038. After deduction of all operating costs the net profit from this source amounted to $27,955.

Of the other mills in the district the Ajax 300-ton concentration mill was idle; the new Reed-Dante (or Big Toad) 100-ton cyanide coarse-crushing leaching plant was operated for a short time; the Isabella and Wild Horse mills were dismantled; the Blue Flag 125-ton continuous-agitation cyanide mill was idle; the Jerry Johnson 100-ton cyanide mill was idle; the old Rex 100-ton cyanide plant was idle. At the Lincoln No. 2 mine was being built, in 1918, a 500-ton direct concentration plant with cyanidation in part, to use the dry Gasche concentration process.

MINES REVIEW.

Poverty Gulch.—The Abe Lincoln and Gold King were the only producing mines.

Tenderfoot Hill.—A considerable quantity of ore was shipped from the Queen Bess property and a small quantity from the Mollie Kathleen mine. Lessees shipped a small quantity of ore from the Ella W. mine.

Globe Hill.—The Deerhorn mine of the Stratton estate mines on this hill was a producer.

Hoosier Pass.—A small quantity of ore was shipped from the Hoosier mine.

North slope of Ironclad Hill.—Producing mines were the Forest Queen, Jerry Johnson, W. P. H. The W. P. H. was operated by the United Gold Mines Co., whose property comprises a large acreage on Bull Hill as well as Ironclad Hill. The Wild Horse mill was dismantled.

Gold Hill.—A small shipment was made from the Anchoria-Leland. Lessees on the Index mine produced a considerable quantity of ore, as did lessees on the Conundrum mine. The Midget mine was idle.

Raven and Guyot Hills.—Producing mines were the Cresson, Doctor-Jack Pot, Elkton, Jo Dandy, and Mary McKinney. A large quantity of low-grade ore was shipped from the old Economic dump.

The Cresson property continued to be one of the principal producing mines in the district. The Elkton mine, once one of the large mines of the district, was operated by lessees only, with a gradual decrease in production. The Victory M. Co., a lessee on the Howard shaft of the Mary McKinney during nine months of 1918, shipped 1,226 tons of ore, with a gross value of $13,872. The company also operated and produced ore from this mine, but the output was not equal to that of 1917.

The Big Toad Mining Co. operated the Dante cyanide mill for a short time.

Beacon Hill.—Producing mines were the C. K. & N. (Raaler), El Paso, Gold Dollar, Mable M., and Prince Albert.

Bull Hill.—Producing mines were the Blue Bird, Dante, Dexter, Gold Sovereign, Modoc, Last Dollar, Stratton Estate mines (American Eagles, Orpha May, Specimen), and the United Gold Mines Co. group.

The annual report of the United Gold Mines Co. for the year ended December 31, 1918, says:

> During the past year the development work of your company has been quite extensive and has proven of value in showing the extension of veins to greater depths, with every indication that ore will be found at some point in the veins. Through the

Wild Horse shaft, on Bull Hill, 1,037 feet of drifting and crosscutting was done on company account, and while some ore was found, it did not prove permanent. This work has been discontinued. Your company did 467 feet of drifting and crosscutting from the Cripple Creek drainage tunnel, but failed to open any ore of commercial value. Three diamond drill holes were also driven from this level; one of these crossing the Trail ground horizontally cut several large veins with small values. This hole was 552 feet long. Two diamond drill holes were driven at an angle upwards into the Big Banta ground, and while these showed that the country had several vertical and flat veins, the values were very low. These two holes were about 275 feet. The total development, including the diamond drilling, exceeds that of 1917. In view of the high costs of all mining supplies and the scarcity of labor, this is very gratifying to your management. The Anderson & Benkelman lease on the Trail mine continues to be the principal shipper among the lessees. They are now doing work on the fourteenth level, which will open up ore they worked in the higher levels.

Royalty receipts were $48,785.

Mines between Altman and Goldfield.—Producing mines were the Acacia (Burns), Golden Cycle, Isabella, Pharmacist, Victor, and Vindicator.

The Isabella mine was continuously operated in 1918 through the Lee shaft. The mill was not operated and was dismantled and sold for junk.

The Vindicator Consolidated Gold Mining Co. in its annual report for the year ended December 31, 1918, (dated February 10, 1919), says:

> The total development from the Vindicator and Golden Cycle shafts for the year amounted to 5,113 feet, of which 2,899 feet was driven by lessees.
>
> Early in the year development work was discontinued on the twentieth level of the Golden Cycle shaft, the bottom level. On this level a total of 4,240 feet of work has been done, and no ore of a commercial grade exposed. This work has systematically explored the known ore zones which at this level should possibly produce ore; the vein systems were found in place and the fracturing was strong and well defined, and with a general physical appearance favorable to ore deposition. However, the values necessary to make commercial ore were lacking.
>
> This level is at a depth of 2,150 feet from the collar of the shaft, and at an elevation of 7,920 feet above sea level. The productive areas in the property maintained well with depth to an elevation of about 8,300 feet above sea level. In sinking below this elevation there was a gradual but marked decrease in the production of areas, the ore shoots being more broken up and showing a decrease in the average grade of the ore produced. Extensive work has been done on the twentieth level with the view of developing ore below a possible barren zone existing at the elevation of the nineteenth level, with negative results.
>
> There are possibly existing ore bodies at a greater depth, but it is the opinion of our operating staff from a thorough study of the habits of the existing ore bodies, that there will not in this property be sufficient ore opened up at a greater depth than that to which exploration work has been carried, to warrant the expenses of sinking and exploring. However, this does not mean that exploration work should stop, as we have a considerable area on the upper levels of the property which has not been thoroughly prospected, and it is the intention of the management to explore this territory during the ensuing year. Due to the intense labor shortage during the year 1918, this work was impossible. In the last two months there has been a marked increase in the number of available men and exploration has again been started in the upper levels. The results of this work to the date of this report, while limited, have been encouraging, and we hope during the year 1919 to develop an appreciable tonnage of commercial ore.
>
> The ore reserves of the company have been greatly depleted during the past year. This has been due to the fact that it was possible to accomplish but a moderate amount of development work, and the work that was done has not opened up an appreciable amount of ore.
>
> The ore reserves in the mine as at January 1, 1919, total 104,230 tons of average grade ore.
>
> After the discontinuation of work on the bottom levels of the mine, the nineteenth and twentieth levels were cleaned up, all pipe, track, and other material was removed, and the work of dismantling and removing the pumps from the bottom level was commenced. This work was completed and the pumping was stopped on June 27, 1918.
>
> The lower workings of the mine filled rapidly, but it was our hope that when the water rose to the level of the Roosevelt drainage tunnel there would be a diminution

of the volume of water we would have to handle, if not a complete elimination of the pumping problem. However, this proved not to be the case, and on July 27, 1918, we had to resume pumping from the eighteenth level of the mine.

As the drainage tunnel has reached the shaft of the Portland Gold Mining Co., the indication is that there is an impervious dyke lying between our property and the Portland property, and the drainage tunnel does not appear to assist in the draining of the area covered by the Vindicator property

Battle Mountain.—Producing mines were the Ajax, Carbonate Queen, Granite, Portland, Independence, and Strong.

The twenty-fifth annual report of the Portland Gold Mining Co., for the year ended December 31, 1918 (dated February 17, 1919), says:

In our last annual report, your attention was called to the difficult and discouraging war conditions under which your properties had been operated during the preceding year. We regret that the adverse conditions surrounding gold mining in the Cripple Creek district during 1917 continued in an accentuated form throughout the year 1918. Our mine and our mills were operated during the first four months of the year without profit and at times it seemed as though the obstacles continually arising, such as shortage of efficient labor, the difficulty of procuring the necessary supplies and their increasing cost, would force a closing down of the entire property. However, by closing the Colorado Springs mill, by combining the business of the Victor mill with that of the Independence plant, by reducing development work to the minimum, and by introducing economies in every direction, your board of directors was able to avert the threatened disaster, and both the mine and the Independence mill were kept in continuous operation throughout the entire year. During the last eight months a fair profit was earned. The limited amount of development work done will doubtless reduce the output somewhat during the coming year, and some of the economies adopted may prove expensive in the long run; yet the losses therefrom will be small in comparison with what they would have been in damage to the properties and through loss of the organization, had all the properties been closed down.

The most important event in connection with the affairs of your company during the last year was the completion of a branch tunnel from the Roosevelt drainage tunnel to a connection with Portland shaft No. 2 at a depth of 2,131 feet from the surface. The main drainage tunnel, work on which was commecned eleven years ago, is 24,255 feet in length from its portal to its heading, which is located about the middle of the northerly portion of the company's property. The total expense to the Portland Co. toward construction of this tunnel and of the lateral to its No. 2 shaft was $144,952.

On December 29, our main shaft was sunk to the twenty-first or drainage tunnel level. The work of timbering the shaft and cutting out a station of sufficient size to install pumps and to allow room for the work of opening up the high-grade ore bodies located there, will soon be accomplished. We will then commence driving on our No. 1 vein, which contains the largest and best ore body we have. This will enable us to increase materially our high-grade production. Our Lee No. 5 ore body was cut by the drainage tunnel crosscut, and drifting on that ore body is now opening up good high-grade ore. When these ore bodies are sufficiently opened up, stoping will be commenced for the more rapid production of ore.

At the beginning of 1918 we had a good cash balance in our treasury, but the excessive cost of supplies, the heavy draft on our skilled labor by the Government, and the shortage of experienced miners which compelled us to fill our vacancies with unskilled men, increased our operating expense so much that we carefully considered the situation thus brought about and acted accordingly. In July, on account of the very small profits earned during the first half of the year, we reduced our quarterly dividends from 3 cents to 2 cents per share, as it was evident that a considerable part of our dividend for the year would have to be paid out of our accumulated surplus earnings.

Taking everything into consideration, the outlook for the future is promising. The profits from our Independence mill should be sufficient to pay dividends at the present rate during the coming year. The labor situation is improving, and if the ore bodies on the twenty-first level and below it, which are made accessible by the branch tunnel, prove to be measurably near as productive as we anticipate, the net earnings from the mine for the year should be sufficient to build up the treasury cash balance to satisfactory dimensions.

The Strong mine was closed October 31, 1918, after many years of productive activity.

COPPER.

By B. S. Butler.

INTRODUCTION.

In the production of metallic copper suitable for commercial purposes at least three distinct processes are usually required, namely, mining, smelting, and refining. The Lake Superior native-copper district is the only important producing region where these three processes are not entirely distinct. It is possible, therefore, to ascertain the copper output of the country by collecting statistics from the mines, from the smelters, and from the refineries, and each of these sets of figures has its advantages. The mine figures have the advantage of giving the most accurate distribution of the production but are less accurate in total quantity of copper recovered; the smelter figures permit reasonably accurate distribution and also furnish the actual recovery of copper from the ores treated during the year; the refinery figures furnish the best measures of the copper made available for commercial uses during the year, but at this stage of manufacture the accurate distribution to the State of origin, or even the separation of copper derived from domestic and from foreign sources, is uncertain.

Statistics for 1918 showing the production of each of these stages of manufacture have been collected by the United States Geological Survey and are presented in the following report.

As the same material passes through the three processes of manufacture at successive periods, usually requiring two to three months from the time it is taken from the mine before it reaches the stage of refined copper, the year's production as recorded for the different stages does not represent the same materials—that is, the refinery production for the calendar year 1918 represents the mine production from about October 1, 1917, to October 1, 1918. The three sets of figures representing the successive stages of manufacture do not, therefore, necessarily agree, although they should not differ greatly if the condition of the industry is normal. The mine figures and the smelter figures will differ by the difference in the quantity of ore, matte, and other materials in stock at the beginning and at the end of the year and by the difference in the quantity of copper reported by the mines and that recovered by the smelters. The latter difference is due to the fact that considerable copper is recovered from sulphur, lead, zinc, and siliceous ores carrying so little copper that the mines do not receive pay for and frequently do not report the copper content of the ore, although it is eventually recovered by the smelters. The smelter and refinery figures will differ by the increase or decrease in stock of blister and other unrefined forms of copper at the beginning and at the end of the year and by the loss in refining.

As the smelter production permits reasonably accurate distribution as to the source by States and also gives the actual output of copper, it is adopted in this report as the production of the country. It is made up of the production of blister copper and of furnace-refined or ingot copper of the Lake district.

SUMMARY OF STATISTICS.

Summary of statistics of the copper industry in the United States in 1912–1918.

	1912	1913	1914	1915
Production of copper:				
Smelter output............pounds..	1,243,268,720	1,224,484,098	1,150,137,192	1,388,009,527
Mine production.............do....	1,249,094,891	1,235,569,727	1,148,431,437	1,488,071,528
Refinery production of new copper:				
Electrolytic...........pounds..	914,935,371	1,022,497,601	991,573,073	1,114,345,343
Lake....................do....	231,112,228	155,715,286	158,009,748	236,757,063
Casting and pig..........do....	57,629,296	58,611,026	60,840,368	36,603,119
Total domestic..........do....	1,203,676,895	1,236,823,913	1,210,423,189	1,387,705,528
Total domestic and foreign, ...pounds..	1,568,104,478	1,615,067,782	1,533,781,394	1,634,204,448
Total new and old copper.....do....	1,843,000,000	1,888,000,000	1,790,000,000	2,027,000,000
Total ore produced.........short tons..	35,671,028	36,361,101	35,187,118	43,415,133
Copper ore produced............do....	35,656,414	36,336,682	35,175,541	43,404,183
Average yield of copper..per cent..	1.71	1.67	1.60	1.66
Average price per pound........cents..	16.5	15.5	13.3	17.5
Imports[a]......................pounds..	410,241,295	408,778,954	306,350,827	315,698,449
Exports of metallic copper[b]......do....	775,000,658	926,241,092	840,080,922	681,917,855
Consumption:				
Total new copper............do....	775,978,332	812,268,639	701,624,158	1,136,618,187
Total new and old copper....do....	1,051,000,000	1,085,000,000	958,000,000	1,529,000,000
World's production..............do....	2,208,690,000	2,133,295,000	2,023,344,000	2,325,994,000
Value of production in the United States............................	$205,139,338	$189,795,035	$152,968,000	$242,902,000

	1916	1917	1918
Production of copper:			
Smelter output............................pounds..	1,927,850,548	1,886,120,721	1,908,533,595
Mine production.................................do....	2,005,875,312	1,895,434,349	1,910,022,841
Refinery production of new copper:			
Electrolytic..............................do....	1,579,620,513	1,452,744,593	1,560,327,428
Lake......................................do....	269,794,531	268,508,091	231,096,158
Casting and pig..........................do....	39,337,155	152,293,487	91,450,611
Total domestic...........................do....	1,888,752,199	1,873,546,171	1,882,874,191
Total domestic and foreign..............do....	2,259,387,315	2,428,546,171	2,432,385,290
Total new and old copper....................do....	2,959,000,000	3,195,000,000	3,138,000,000
Total ore produced.........................short tons..	57,953,357	58,514,325	62,304,767
Copper ore produced.............................do....	57,863,365	58,482,694	62,289,009
Average yield of copper...................per cent..	1.70	1.60	1.51
Average price per pound.......................cents..	24.6	27.3	24.7
Imports[a]......................................pounds..	462,335,980	556,420,297	575,806,115
Exports of metallic copper[b]......................do....	784,006,486	1,125,647,336	744,343,481
Consumption:			
Total new copper...........................do....	1,478,881,871	1,394,829,715	1,661,669,576
Total new and old copper.....................do....	2,179,000,000	2,162,000,000	2,367,000,000
World's production...............................do....	2,993,725,000	3,147,258,000	(c)
Value of production in the United States............	$474,288,000	$514,911,000	$471,408,000

[a] Copper in unmanufactured form.

[b] Total exports of copper exclusive or ore, concentrates, and composition metal.

[c] Returns incomplete. See p. 881.

Copper produced in the United States, 1913–1918.

[Smelter output, in pounds fine.]

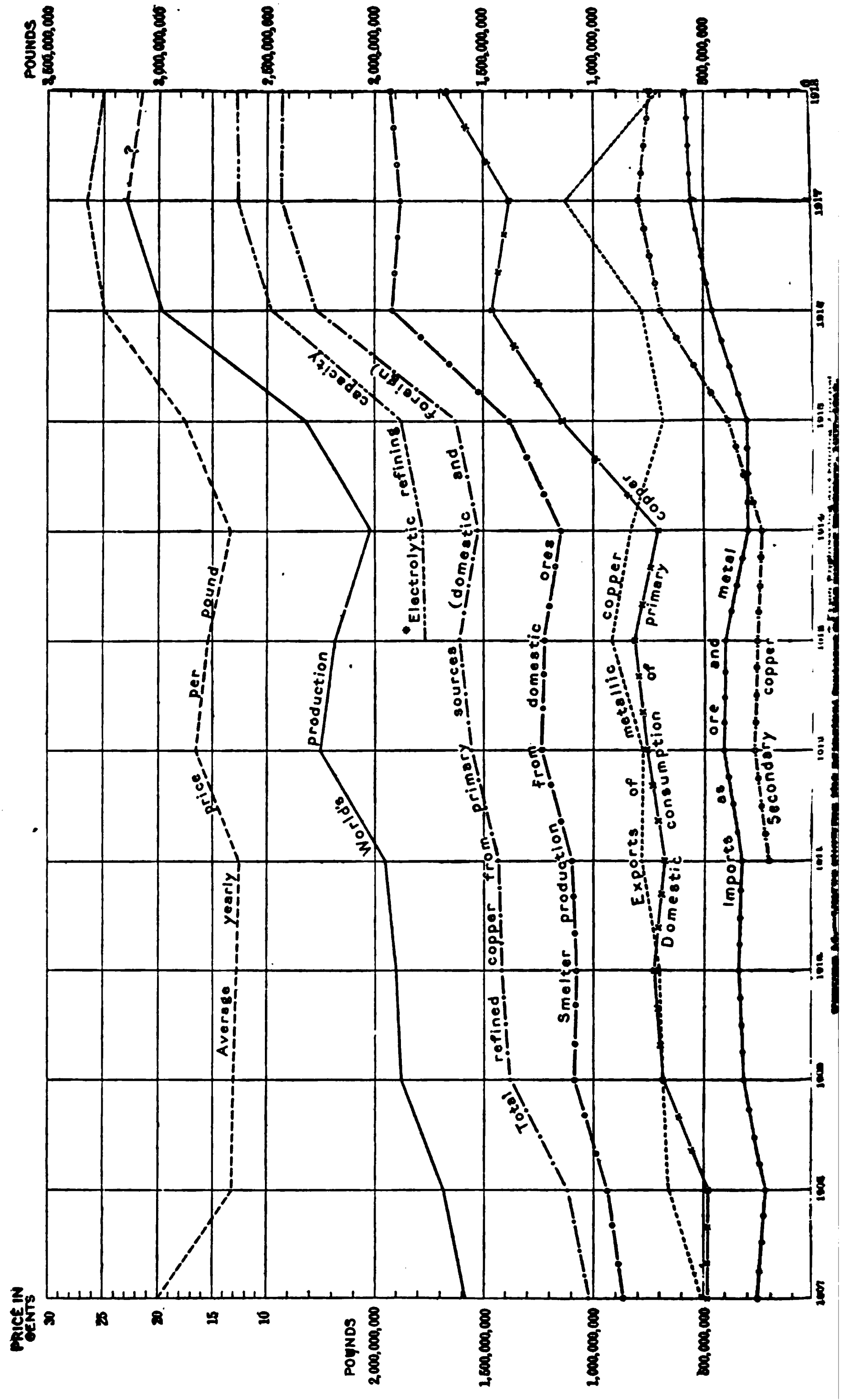
	1913	1914	1915	1916	1917	1918
Alaska	23,423,070	24,985,847	70,695,286	113,823,064	84,759,086	67,081,648
Arizona	404,278,809	382,449,922	432,467,690	694,847,307	719,035,514	769,521,729
California	32,492,265	29,784,173	37,658,444	43,400,876	44,933,846	44,150,761
Colorado	9,052,104	7,316,066	7,272,178	9,536,193	10,054,951	7,591,570
Georgia	....	....	....	803,699	930,691	397,078
Idaho	8,711,490	5,875,205	6,217,728	7,248,794	6,446,224	5,836,795
Maine	....	....	....	....	34,872	501,169
Maryland	....	12,248	15,426	126,965	291,501	....
Michigan	155,715,286	158,009,748	238,956,410	269,794,531	268,508,091	231,096,158
Missouri	576,204	53,519	306,406	377,575	407,141	232,073
Montana	285,724,467	236,805,845	268,263,040	352,139,768	276,225,977	326,426,761
Nevada	85,209,536	60,122,904	67,757,322	100,816,724	115,028,161	106,266,603
New Jersey	....	....	....	4,115	....	....
New Mexico	50,196,881	64,204,703	62,817,234	79,863,439	107,593,615	96,559,580
North Carolina	180	19,712	33,383	5,961	125,004	79,200
Oregon	77,812	5,599	797,471	2,433,567	1,105,097	2,630,499
Pennsylvania	245,337	422,741	....	904	115,000	34,500
South Carolina	....	....	....	....	210,000	....
Tennessee	19,489,654	18,661,112	18,205,308	14,556,278	16,093,757	15,053,568
Texas	39,008	34,272	38,971	86,463	2,061,129	13,851
Utah	148,057,450	160,589,660	175,177,695	232,335,950	227,840,447	230,964,908
Vermont	5,771	....	23,995	324,400	102,522	896,630
Virginia	46,961	17,753	50,008	1,066,143	146,912	1,248
Washington	732,742	683,602	903,661	2,473,481	2,051,416	2,330,568
Wyoming	362,235	17,082	351,871	1,784,351	2,019,767	866,698
Undistributed	46,836	65,479	....	....	....	....
	1,224,484,098	1,150,137,192	1,388,009,527	1,927,850,548	1,886,120,721	1,908,533,595

Principal features of the copper industry, 1907–1918.

Year.	Refined copper, primary.	Secondary copper.	Smelter production, domestic ores.	Imports, in unmanufactured form.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
1907	1,032,500,000	....	869,000,000	253,000,000
1908	1,138,000,000	....	942,500,000	219,000,000
1909	1,391,000,000	....	1,093,000,000	322,000,000
1910	1,422,000,000	....	1,080,000,000	344,000,000
1911	1,434,000,000	214,000,000	1,097,000,000	335,000,000
1912	1,568,100,000	275,000,000	1,243,000,000	410,000,000
1913	1,615,100,000	273,000,000	1,224,000,000	409,000,000
1914	1,533,800,000	256,000,000	1,150,000,000	306,000,000
1915	1,634,200,000	392,000,000	1,388,000,000	316,000,000
1916	2,259,400,000	700,000,000	1,928,000,000	462,000,000
1917	2,428,500,000	767,000,000	1,886,000,000	556,000,000
1918	2,432,400,000	705,000,000	1,908,500,000	576,000,000

Year.	Exports of metallic copper.	Domestic consumption (new copper).	Average yearly price per pound.	World's production.
	Pounds.	*Pounds.*		*Pounds.*
1907	509,000,000	488,000,000	$0.200	1,595,553,000
1908	662,000,000	480,000,000	.132	1,651,091,000
1909	683,000,000	689,000,000	.130	1,831,826,000
1910	708,000,000	732,000,000	.127	1,900,606,000
1911	786,500,000	682,000,000	.125	1,967,945,000
1912	775,000,000	776,000,000	.165	2,208,690,000
1913	926,000,000	812,000,000	.155	2,133,295,000
1914	840,000,000	702,000,000	.133	2,023,344,000
1915	682,000,000	1,137,000,000	.175	2,325,994,000
1916	784,000,000	1,479,000,000	.246	2,993,725,000
1917	1,126,000,000	1,395,000,000	.273	3,147,258,000
1918	744,000,000	1,662,000,000	.247	(a)

[a] Returns incomplete. See p. 881.


POUNDS
3,500,000,000
3,000,000,000
2,500,000,000
2,000,000,000
1,500,000,000
1,000,000,000
500,000,000
PRICE IN CENTS
30
25
20
15
10
POUNDS
2,000,000,000
1,500,000,000
1,000,000,000
500,000,000
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
Average yearly price per pound
?
World's production
Electrolytic refining capacity
*
Total refined copper from primary sources (domestic and foreign)
Smelter production from domestic ores
Exports of metallic copper
Domestic consumption of primary copper
Imports as ore and metal
Secondary copper

[illegible]

World's production of copper (smelter output), 1908–1918, in pounds.[a]

[Compiled by Miss H. M. Meyer under direction of H. A. C. Jenison.]

Country.	1908	1909	1910	1911	1912	1913
Austria-Hungary	[b] 3,748,000	[b] 3,748,000	[b] 5,071,000	[b] 5,732,000	[b] 8,818,000	[b] 9,039,000
England	12,187,000	8,325,000	9,359,000	7,306,000	4,330,000	6,120,000
Germany	45,194,000	50,265,000	55,334,000	49,383,000	56,438,000	55,776,000
Italy	6,228,000	5,589,000	3,893,000	3,673,000	5,112,000	4,610,000
Norway	3,508,000	3,406,000	3,999,000	3,450,000	4,696,000	6,043,000
Portugal	[c] 17,637,000	[c] 17,637,000	[c] 15,432,000	[c] 16,535,000	[c] 14,330,000	[c] 12,787,000
Russia	37,771,000	39,244,000	50,014,000	57,201,000	74,895,000	74,283,000
Serbia	[b] 4,850,000	[b] 10,141,000	[b] 10,803,000	[b] 15,432,000	[b] 16,314,000	[b] 14,109,000
Spain	99,323,000	98,968,000	106,993,000	108,490,000	134,520,000	68,889,000
Sweden	6,191,000	5,236,000	6,859,000	7,101,000	8,724,000	9,292,000
Turkey	[b] 2,425,000	[b] 1,764,000	[b] 1,323,000	[b] 2,205,000	[b] 1,102,000	[b] 1,102,000
Total Europe	239,062,000	244,323,000	269,080,000	276,508,000	329,279,000	262,050,000
Canada	63,702,873	52,493,863	55,692,369	55,648,011	77,832,127	76,976,925
Cuba	[b] 6,614,000	[b] 6,614,000	[b] 7,716,000	[b] 8,377,000	[b] 9,700,000	[b] 7,495,000
Mexico	67,047,000	96,116,000	116,233,000	131,001,000	121,402,000	[c] 116,402,000
Newfoundland	[b] 3,307,000	[b] 3,087,000	[b] 2,425,000	[b] 2,646,000	[b] 1,102,000	....
United States	942,570,721	1,092,951,624	1,080,159,509	1,097,232,749	1,243,268,720	1,224,484,098
Total North America	1,083,241,000	1,251,262,000	1,262,226,000	1,294,905,000	1,453,305,000	1,425,358,000
Argentina	[b] 441,000	[b] 1,323,000	[b] 661,000	[b] 2,205,000	[b] 661,000	[b] 220,000
Bolivia	[d] 5,600,000	[d] 4,480,000	[d] 5,600,000	[d] 4,032,000	[d] 4,145,000	1,980,000
Chile	94,791,000	94,193,000	84,286,000	80,291,000	91,815,000	93,174,000
Peru	43,770,000	44,242,000	60,349,000	61,145,000	59,456,000	61,235,000
Venezuela	....	....	....	[c] 1,609,000	[c] 1,874,000	[c] 1,587,000
Total South America	144,602,000	144,238,000	150,896,000	149,282,000	157,951,000	158,196,000
Belgian Congo	....	....	....	[c] 2,227,000	[c] 5,578,000	[c] 16,601,000
Namaqualand	[b] 5,291,000	[b] 5,070,000	[b] 5,512,000	[b] 5,512,000	[b] 5,512,000	[b] 5,512,000
Southern Rhodesia	187,000	194,000	86,000	....	....	....
Union of South Africa	[c] 2,381,000	[c] 3,638,000	[c] 5,842,000	20,416,000	17,279,000	18,337,000
Total Africa	7,859,000	8,902,000	11,440,000	28,155,000	28,369,000	40,450,000
Japan	89,624,000	101,061,000	108,740,000	117,730,000	137,618,000	146,608,000
Australia	[e] 86,703,000	[e] 82,040,000	98,224,000	101,365,000	102,168,000	100,633,000
Grand total	1,651,091,000	1,831,826,000	1,900,606,000	1,967,945,000	2,208,690,000	2,133,295,000

Country.	1914	1915	1916	1917	1918
Austria-Hungary	[c] 7,275,000	....	....	....	....
England	5,730,000	1,841,000	2,302,000	2,599,000	2,718,000
Germany	[c] 66,138,000	[c] 77,161,000	[c] 77,161,000	[c] 99,208,000	[c] 88,184,000
Italy	4,054,000	2,072,000	4,116,000	2,934,000	([g])
Norway	6,305,000	6,235,000	3,558,000	[c] 4,409,000	[c] 4,850,000
Portugal	[c] 10,075,000	[c] 9,458,000	[c] 9,502,000	[c] 9,480,000	([g])
Russia	71,284,000	57,236,000	[c] 29,497,000	[c] 37,478 000	([g])
Spain	56,671,000	76,497,000	72,487,000	84,934,000	99,436,000
Sweden	10,344,000	10,055,000	7,013,000	9,751,000	6,517,000
Total Europe	237,876,000	240,555,000	205,636,000	250,793,000	([g])
Canada	75,735,960	100,785,150	117,150,028	109,227,332	118,769,434
Cuba	[c] 13,890,000	[c] 19,621,000	[c] 20,944,000	[c] 23,589,000	([g])
Mexico	[c] 80,116,000	45,410,000	62,634,000	112,404,000	154,814,000
United States	1,150,137,192	1,388,009,527	1,927,850,548	1,886,120,721	1,908,533,595
Total North America	1,319,879,000	1,553,826,000	2,128,579,000	2,131,341,000	([g])
Argentina	[c] 661,000	[c] 661,000	[c] 661,000	[c] 661,000	[c] 661,000
Bolivia	4,190,000	11,460,000	14,110,000	16,750,000	[f] 13,450,000
Chile	98,469,000	115,392,000	157,161,000	226,032,000	[c] 253,529,000
Peru	59,723,000	76,561,000	94,970,000	99,595,000	97,915,000
Venezuela	[c] 1,587,000	[c] 1,653,000	[c] 1,852,000	[c] 1,896,000	[c] 3,616,000
Total South America	164,630,000	205,727,000	268,754,000	344,934,000	369,171,000
Belgian Congo	[c] 24,007,000	[c] 31,482,000	[c] 49,604,000	[c] 61,509,000	[c] 45,327,000
Namaqualand	[c] 5,512,000	....	....	....	....
Southern Rhodesia	2,022,000	7,035,000	7,041,000	7,822,000	6,508,000
Union of South Africa	25,342,000	24,235,000	23,256,000	17,859,000	10,635,000
Total Africa	56,883,000	62,752,000	79,901,000	87,190,000	62,470,000
Japan	155,343,000	166,262,000	221,862,000	245,125,000	190,910,000
Australia	88,733,000	96,872,000	88,993,000	87,875,000	[e] 87,591,000
Grand total	2,023,344,000	2,325,994,000	2,993,725,000	3,147,258,000	([g])

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[a] Where no footnotes are given, figures are taken from official publications. For countries from which ore or matte was exported for smelting, official figures have been converted to figures showing the quantity of copper recoverable by the smelters.

[b] Compiled by Henry Merton & Co. (Ltd.).

[c] Estimated by the United States Geological Survey.

[d] Figures taken from Chilean official publication.

[e] Almost completely official. A small part estimated by the United States Geological Survey.

[f] Incomplete.

[g] Figures not yet available.

World's production of copper (smelter output), 1908–1918, in metric tons.[a]

[Compiled by Miss H. M. Meyer under direction of H. A. C. Jenison.]

Country.	1908	1909	1910	1911	1912	1913
Austria-Hungary	[b] 1,700	[b] 1,700	[b] 2,300	[b] 2,600	[b] 4,000	[b] 4,100
England	5,528	3,776	4,245	3,314	1,964	2,776
Germany	20,500	22,800	25,100	22,400	25,600	25,300
Italy	2,825	2,535	1,766	1,666	2,319	2,091
Norway	1,591	1,545	1,814	1,565	2,130	2,741
Portugal	[c] 8,000	[c] 8,000	[c] 7,000	[c] 7,500	[c] 6,500	[c] 5,800
Russia	17,133	17,801	22,686	25,946	33,972	33,694
Serbia	[b] 2,200	[b] 4,600	[b] 4,900	[b] 7,000	[b] 7,400	[b] 6,400
Spain	45,053	44,892	48,532	49,211	61,018	31,248
Sweden	2,806	2,375	3,111	3,221	3,957	4,215
Turkey	[b] 1,100	[b] 800	[b] 600	[b] 1,000	[b] 500	[b] 500
Total Europe	108,438	110,824	122,054	125,423	149,360	118,865
Canada	28,895	23,811	25,262	25,242	35,304	34,916
Cuba	[b] 3,000	[b] 3,000	[b] 3,500	[b] 3,800	[b] 4,400	[b] 3,400
Mexico	30,413	43,598	52,723	59,421	55,068	[c] 52,800
Newfoundland	[b] 1,500	[b] 1,400	[b] 1,100	[b] 1,200	[b] 500	....
United States	427,547	495,760	489,957	497,702	563,943	555,422
Total North America	491,355	567,569	572,542	587,365	659,215	646,538
Argentina	[b] 200	[b] 600	[b] 300	[b] 1,000	[b] 300	[b] 100
Bolivia	[d] 2,540	[d] 2,032	[d] 2,540	[d] 1,829	[d] 1,880	900
Chile	42,997	42,726	38,232	36,420	41,647	42,263
Peru	19,854	20,068	27,374	27,735	26,969	27,776
Venezuela	....	....	....	[c] 730	[c] 850	[c] 720
Total South America	65,591	65,426	68,446	67,714	71,646	71,759
Belgian Congo	....	....	....	[c] 1,010	[c] 2,530	[c] 7,530
Namaqualand	[b] 2,400	[b] 2,300	[b] 2,500	[b] 2,500	[b] 2,500	[b] 2,500
Southern Rhodesia	85	88	39	....	....	....
Union of South Africa	[c] 1,080	[c] 1,650	[c] 2,650	9,261	7,838	8,318
Total Africa	3,565	4,038	5,189	12,771	12,868	18,348
Japan	40,653	45,841	49,324	53,402	62,423	66,501
Australia	[e] 39,328	[e] 37,213	44,554	45,979	46,343	45,647
Grand total	748,930	830,911	862,109	892,654	1,001,855	967,658

Country.	1914	1915	1916	1917	1918
Austria-Hungary	[c] 3,300	....	....	....	....
England	2,599	835	1,044	1,179	1,233
Germany	[c] 30,000	[c] 35,000	[c] 35,000	[c] 45,000	[c] 40,000
Italy	1,839	940	1,867	1,331	(g)
Norway	2,860	2,828	1,614	[c] 2,000	[c] 2,200
Portugal	[c] 4,570	[c] 4,290	[c] 4,310	[c] 4,300	(g)
Russia	32,334	25,962	[c] 13,380	[c] 17,000	(g)
Spain	25,706	34,699	32,880	38,526	45,104
Sweden	4,692	4,561	3,181	4,423	2,956
Total Europe	107,900	109,115	93,276	113,759	(g)
Canada	34,354	45,716	53,139	49,545	53,873
Cuba	[c] 6,300	[c] 8,900	[c] 9,500	[c] 10,700	(g)
Mexico	[c] 36,340	20,598	28,411	50,986	70,223
United States	521,699	629,597	874,467	855,539	865,705
Total North America	598,693	704,811	965,517	966,770	(g)
Argentina	[c] 300	[c] 300	[c] 300	[c] 300	[c] 300
Bolivia	1,900	5,200	6,400	7,600	[f] 6,100
Chile	44,665	52,341	71,288	102,527	[c] 115,000
Peru	27,090	34,728	43,078	45,176	44,414
Venezuela	[c] 720	[c] 750	[c] 840	[c] 860	[c] 1,640
Total South America	74,675	93,319	121,906	156,463	167,454
Belgian Congo	[c] 10,890	[c] 14,280	[c] 22,500	[c] 27,900	[e] 20,560
Namaqualand	[c] 2,500	....	....	....	....
Southern Rhodesia	917	3,191	3,194	3,548	2,952
Union of South Africa	11,495	10,993	10,549	8,101	4,824
Total Africa	25,802	28,464	36,243	39,549	28,336
Japan	70,463	75,416	100,636	111,188	86,596
Australia	40,249	43,941	40,367	39,860	[e] 39,731
Grand total	917,782	1,055,066	1,357,945	1,427,589	(g)

[a] Where no footnotes are given, figures are taken from official publications. For countries from which ore or matte was exported for smelting, official figures have been converted to figures showing the quantity of copper recoverable by the smelters.

[b] Compiled by Henry Merton & Co. (Ltd.).

[c] Estimated by the United States Geological Survey.

[d] Figures taken from Chilean official publication.

[e] Almost completely official. A small part estimated by the United States Geological Survey.

[f] Incomplete.

[g] Figures not yet available.

GENERAL CONDITION OF THE INDUSTRY.

The outstanding features of the copper industry for the year 1918 were the shortage and inefficiency of labor and the difficulties of transportation.

At the beginning of the year large quantities of copper were caught in the transportation jams or shipment from the smelters was prevented, and the refineries were short of raw material. By the time that this situation had somewhat cleared the refineries were unable to operate at full capacity on account of shortage of labor. The shortage of shipping facilities steadily increased, however, necessitating the elimination of as much shipping as possible. An order was issued by the United States Shipping Board on July 12, 1918, cutting off the importation of copper ore into the United States, except from Canada, Mexico, and Cuba, and of concentrates containing less than 60 per cent of copper. The order concerning concentrates was modified September 8, 1918, to include copper concentrates containing 50 per cent of copper. These restrictions were continued until after the signing of the armistice. The net result of the different factors affecting supply was that domestic production and imports showed little change from 1917. There was a notable increase in domestic consumption and an equally notable decrease in exports. The former was due to added production of war materials for our forces and the latter partly to the fact that exports were very small after the signing of the armistice.

The inability of the refineries to treat the crude copper as fast as it was produced resulted in the accumulation of large stocks of raw copper, which, together with stocks of refined copper held in this country and abroad and of material in various stages of manufacture for war purposes that had to be turned to other uses, resulted in unprecedented stocks at the close of the year. The industry faced the serious problem of disposing of these accumulated stocks and at the same time keeping the producing organizations intact.

The accompanying diagrams (figs. 15 and 16) and tables show the monthly situation of production and stocks for the period October, 1917, to December, 1918.

Summary of monthly report of copper for October, 1917, to December, 1918.

Month.	Refinery production, including "Lake" and imports of refined (calculated from weekly reports).	Smelter production, including foreign that is refined in the United States and "Lake."	Stocks of blister copper at smelting plants, including those in Canada, Mexico, and South America that ship to the United States.[a]	Blister copper in transit to refineries, including that from Mexico, Canada, and South America.[a]
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
October, 1917	176,415,000	199,126,000	14,252,000	106,940,000
November	182,822,000	196,064,000	9,234,000	134,874,000
December	169,188,000	220,126,000	8,114,000	163,194,000
January, 1918	166,087,000	204,022,000	15,768,000	202,594,000
February	155,205,000	180,692,000	54,574,000	219,980,000
March	189,150,000	216,877,000	27,258,000	250,224,000
April	198,518,000	209,678,000	30,666,000	220,170,000
May	213,024,000	218,118,000	29,380,000	240,112,000
June	212,888,000	204,618,000	28,604,000	255,790,000
July	209,834,000	198,044,000	34,828,000	217,464,000
August	210,804,000	210,238,000	44,342,000	207,806,000
September	202,616,000	200,422,000	26,874,000	225,304,000
October	171,942,000	202,708,000	50,870,000	186,468,000
November	193,008,000	202,238,000	36,896,000	227,404,000
December	209,298,000	207,390,000	31,234,000	240,348,000
January, 1919	....	....	46,960,000	195,030,000

[a] Figures given are for the first of each month.

Summary of monthly report of copper for October, 1917, to December, 1918—Continued.

Month.	Stocks of blister copper at refineries.[a]	"Mineral" at Lake refineries.[a]	Material in process of refining.[a]	Total raw material.[a]
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
October, 1917	35,818,000	3,990,000	185,696,000	346,696,000
November	34,364,000	5,474,000	195,792,000	379,738,000
December	41,256,000	4,338,000	195,274,000	412,176,000
January, 1918	28,260,000	5,750,000	224,084,000	476,456,000
February	20,852,000	7,298,000	214,126,000	516,830,000
March	27,028,000	8,904,000	235,012,000	548,426,000
April	49,872,000	8,818,000	265,274,000	574,800,000
May	64,030,000	8,200,000	286,100,000	627,822,000
June	98,890,000	9,586,000	314,450,000	707,320,000
July	127,802,000	6,338,000	321,970,000	708,402,000
August	125,672,000	8,052,000	309,532,000	695,404,000
September	132,748,000	6,496,000	292,724,000	684,146,000
October	133,010,000	7,622,000	282,320,000	660,290,000
November	117,366,000	7,954,000	281,320,000	670,940,000
December	106,206,000	7,298,000	302,024,000	687,110,000
January, 1919	98,324,000	7,502,000	311,694,000	659,510,000

[a] Figures given are for the first of each month.

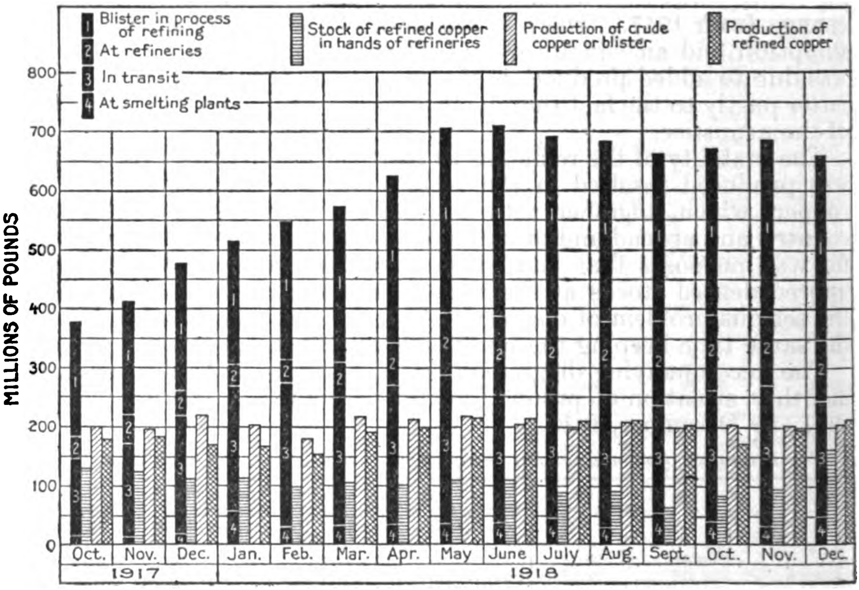

FIGURE 15.—Production of blister and refined copper, by months, October, 1917, to December, 1918, inclusive, and stocks of refined and blister at end of each month in the same period.

The price of copper throughout the year was determined by agreement between the War Industries Board and the copper producers. From January 1 to July 2 it was 23.5 cents a pound; for the remainder of the year it was 26 cents a pound, though there was practically no market after the signing of the armistice.

The copper was apportioned to consumers by the Copper Producers' Committee under the direction of the War Industries Board.

As determined by the Federal Trade Commission, the average cost of producing copper in 1918 for 85 companies, including foreign production of more than 400,000,000 pounds, was 16.167 cents a pound.

The following tables taken from the report of the commission show the quantities of copper produced at different rates of cost and the different items of cost for the several operations and for different regions. The item "approximate duplications" indicates the recoverable copper or copper paid for that has been included twice, owing to the fact that some companies produce ore or concentrates (which have been included in the commission's report) that are sold as such to mining companies that own smelters, which in turn include purchased ore and concentrates in their statistics of costs and production.

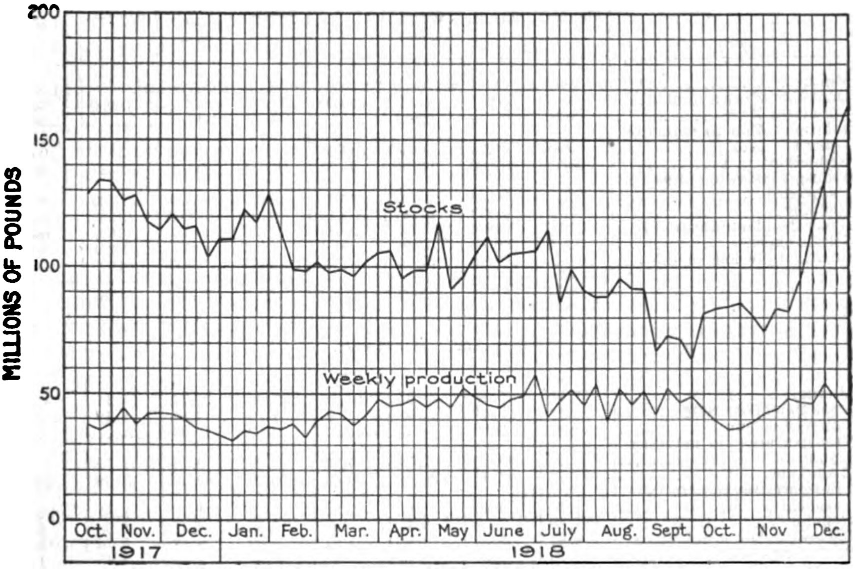

FIGURE 16.—Weekly production and stocks of refined copper (electrolytic, Lake, casting, and pig combined, including that from foreign ores) October, 1917, to December, 1918.

Quantities of copper produced in 1918 at different rates of cost per pound.

[From report of Federal Trade Commission.]

Cost (cents).[a]	Number of companies.	Production (pounds).	Percentage of total.	Accumulated percentage.
Less than 12	2	122,245,051	5.41	5.41
Between 12 and 13	4	208,571,191	9.24	14.65
Between 13 and 14	4	314,553,177	13.93	28.58
Between 14 and 15	4	359,617,743	15.92	44.50
Between 15 and 16	2	98,307,293	4.35	48.85
Between 16 and 17	8	460,528,645	20.39	69.24
Between 17 and 18	9	255,399,096	11.32	80.56
Between 18 and 19	3	72,373,388	3.20	83.76
Between 19 and 20	5	28,491,436	1.26	85.02
Between 20 and 21	5	36,871,193	1.63	86.65
Between 21 and 22	9	135,538,602	6.00	92.65
Between 22 and 23	3	60,861,465	2.70	95.34
Between 23 and 24	5	44,919,772	1.99	97.32
Between 24 and 25	1	6,230,604	.28	97.66
Between 25 and 26	3	7,605,224	.34	97.90
More than 26	18	46,119,555	2.04	100.05
Total reported	85	2,258,234,125	100.00	....
Approximate duplications	....	63,700,000	....	....

[a] All costs show fractions of a cent.

Average cost of production of copper by operations and by geographic divisions, and percentage of each item of cost to total, 1918.

Weighted average cost per pound.

Operation.	Arizona and New Mexico.	Utah, Nevada, and California.	Montana, Idaho, and Washington.	Michigan.	Other United States.	Mexico, Cuba, and South America.	Canada and Alaska.	All companies reporting.
Mining	$0.05615	$0.04277	$0.10858	$0.10693	$0.06403	$0.05532	$0.06198	$0.06946
Depletion of ore at cost	.00627	.00528	.01225	.00608	.00385	.00718	.00999	.00720
Purchases of ore	.01056	.00649	.01613	....	.00403	.00053	....	.00515
Transportation to reduction plant	.00648	.01731	.00436	.00748	.00656	.00491	.01903	.00837
Reduction	.05278	.07800	.05165	.04551	.10988	.06939	.05523	.05891
Transportation to refinery or seaboard	.00728	.00743	.00722	.00416	.00500	.01782	.00620	.00854
Refining	.01183	.01272	.01211	.00114	.01106	.00692	.01398	.01029
General and administrative	.00899	.00892	.00432	.00742	.01730	.01373	.01007	.00899
Selling expense	.00189	.00169	.00025	.00061	.00194	.00421	.00241	.00188
Credit for precious metals	.01048	.01260	.04262	.00211	.02455	.02353	.01626	.01712
	.15175	.16801	.17425	.17622	.19910	.15648	.16263	.16167

Percentage of net cost.

Operation.	Arizona and New Mexico.	Utah, Nevada, and California.	Montana, Idaho, and Washington.	Michigan.	Other United States.	Mexico, Cuba, and South America.	Canada and Alaska.	All companies reporting.
Mining	37.00	25.46	71.57	60.68	32.16	35.35	38.11	42.97
Depletion of ore body	4.13	3.14	7.04	2.88	1.94	4.60	6.14	4.45
Purchases of ore	6.96	3.86	....	....	2.02	.34	....	3.19
Transportation to reduction plant	4.27	10.30	2.50	4.24	3.29	3.14	11.70	5.18
Reduction	34.78	46.43	29.64	25.83	55.19	44.34	33.96	36.44
Transportation to refinery or seaboard	4.80	4.42	4.14	2.36	2.52	11.39	3.81	5.28
Refining	7.80	7.57	6.95	.65	5.55	4.42	8.60	6.36
General and administrative	5.92	5.31	2.48	4.21	8.69	8.77	6.19	5.56
Selling expense	1.25	1.01	.14	.35	.97	2.69	1.48	1.16
Credits	6.91	7.50	24.46	1.20	12.33	15.04	9.99	10.59
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Number of companies	30	14	8	21	2	6	4	85

Production by geographic divisions.

	Pounds.
Arizona and New Mexico	863,493,944
Utah, Nevada, and California	350,323,659
Montana, Idaho, and Washington	331,624,111
Michigan	226,106,184
Other United States	15,838,808
Mexico, Cuba, and South America	350,754,079
Canada and Alaska	120,093,340
All companies reporting	2,258,234,125
Approximate duplications:	
Arizona and New Mexico	23,500,000
Utah, Nevada, and California	4,400,000
Montana, Idaho, and Washington	35,800,000
All companies reporting	63,700,000

The average price received for copper delivered during 1918 was 24.7 cents a pound. Subtracting from this the cost price as determined by the Federal Trade Commission shows an average profit of 8.5 cents a pound. The percentage of profit on capital invested, as determined by the Federal Trade Commission, is shown in the following table:

Investment of copper companies and per cent of return on investment, by geographic groups, 1918.

Group.	Number of companies.	Percentage of production.	Investment.		Percentage of return on investment.
			Amount.	Per pound.	
Arizona and New Mexico	30	38.3	$255,588,541	$0.296	31.7
Utah, Nevada, and California	14	15.5	106,476,596	.304	25.4
Montana, Idaho, and Washington	8	14.7	102,446,087	.309	22.2
Michigan	21	10.0	74,615,578	.330	21.3
Other United States	2	.7	10,527,787	.665	69.3
Mexico, Cuba, and South America	6	15.5	95,854,812	.273	33.3
Canada and Alaska	4	5.3	26,659,515	.222	34.3
Total and average	85	[a] 100.0	672,168,916	.298	28.0

[a] Approximate duplication, 2.8 per cent.

The average quantity of copper yielded by the ore was 1.51 per cent, or 30 pounds to the ton, in 1918, as compared with 1.60 per cent, or 32 pounds to the ton, in 1917. In both years several large plants were treating much more ore than they were designed to treat, and the recovery of copper was low. Improvement in average yield is to be expected with the passing of the necessity for maximum production.

After the signing of the armistice and in preparation for the normal resumption of foreign trade in copper, a copper export association was organized under the provisions of the Webb Act, for concerted action in foreign marketing. Most of the important copper-producing companies became members of this organization.

At the end of 1918 the immediate outlook for the copper industry was not bright. Large stocks of copper had accumulated and the productive capacity had increased out of proportion to the needs of peaceful industries. The export of copper from this country was hampered by the disorganized condition of European industry and the low rate of exchange. The cost of living continued high, and it was not practicable to reduce wages. It was apparent that the industry must go on a production basis far below capacity for an indefinite period. Many of the smaller mines were closed, and the larger mines greatly reduced their output. Most of the companies had foreseen, at least in part, the difficulties that would arise at the end of the war and were in a strong financial condition. Development had been greatly neglected during the period of stress and was now taken up.

All who are familiar with the industry must have the greatest confidence in its future. With the expansion of the electrical and mechanical industries that require copper, it is not unreasonable to expect that within the next score of years we shall see a search for and development of copper deposits quite as intense as the present search for oil. This is well realized by the large mining and exploration companies, which are losing no opportunites to procure territory that has promise of copper deposits.

The copper mines are in a position to meet any probable demands in the immediate future, but few mines have developed reserves that will last at the present rate of production for more than a score of years, and most mines have known reserves for only a few years. Further exploration will certainly greatly extend the life of many deposits, but if the increased rate of consumption in the past (see fig. 1) can be taken as an index of future needs it points to the desirability of a broad policy of exploration and development and indicates that those engaging in such extension of known resources and search for new deposits may reasonably expect adequate rewards for their efforts.

A summary of the copper industry for the year 1918 may well note the death, on June 25, of Dr. James Douglas. For a generation Dr. Douglas had been closely identified with the industry, and in that period he had done much to prepare it for the severe test which it so successfully and creditably met during the war.

PRODUCTION.

SMELTER PRODUCTION.

Copper produced in the United States from 1845 to 1918, inclusive.

[Values rounded.]

Year.	Quantity.	Increase.	Value.	Year.	Quantity.	Increase.	Value.
	Pounds.	*Pounds.*			*Pounds.*	*Pounds.*	
1845	224,000	....	$45,000	1883	115,526,053	24,879,821	$19,062,000
1846	336,000	112,000	57,000	1884	144,946,653	29,420,600	18,843,000
1847	672,000	336,000	124,000	1885	165,875,483	20,928,830	17,915,000
1848	1,120,000	448,000	218,000	1886	157,763,043	a 8,112,440	17,512,000
1849	1,568,000	448,000	349,000	1887	181,477,331	23,714,288	25,044,000
1850	1,456,000	a 112,000	320,000	1888	226,361,466	45,440,942	38,029,000
1851	2,016,000	560,000	334,000	1889	226,775,962	414,496	30,615,000
1852	2,464,000	448,000	542,000	1890	259,763,092	32,987,130	40,523,000
1853	4,480,000	2,016,000	985,000	1891	284,121,764	24,358,672	36,368,000
1854	5,040,000	560,000	1,108,000	1892	344,998,679	60,876,915	40,020,000
1855	6,720,000	1,680,000	1,814,000	1893	329,354,398	a 15,644,281	35,570,000
1856	8,960,000	2,240,000	2,419,000	1894	354,188,374	24,833,976	33,648,000
1857	10,752,000	1,792,000	2,688,000	1895	380,613,404	26,425,030	40,726,000
1858	12,320,000	1,568,000	2,833,000	1896	460,061,430	79,448,026	49,687,000
1859	14,112,000	1,792,000	3,104,000	1897	494,078,274	34,016,844	59,289,000
1860	16,128,000	2,016,000	3,709,000	1898	526,512,987	32,434,713	65,288,000
1861	16,800,000	672,000	3,696,000	1899	568,666,921	42,153,934	97,242,000
1862	21,160,000	4,360,000	4,655,000	1900	606,117,166	37,450,245	100,615,000
1863	19,040,000	a 2,120,000	6,473,000	1901	602,072,519	a 4,044,647	100,546,000
1864	17,920,000	a 1,120,000	8,422,000	1902	659,508,644	57,436,125	90,460,000
1865	19,040,000	1,120,000	7,473,000	1903	698,044,517	38,535,873	95,632,000
1866	19,936,000	896,000	6,828,000	1904	812,537,267	114,492,750	104.005,000
1867	22,400,000	2,464,000	5,682,000	1905	888,784,267	76,247,000	138,650,000
1868	25,984,000	3,584,000	5,976,000	1906	917,805,682	29,021,415	177,136,000
1869	28,000,000	2,016,000	6,790,000	1907	868,996,491	a 48,809,191	173,799,000
1870	28,224,000	224,000	5,977,000	1908	942,570,721	73,574,230	124,419,000
1871	29,120,000	896,000	7,023,000	1909	1,092,951,624	150,380,903	142,084,000
1872	28,000,000	a 1,120,000	9,956,000	1910	1,080,159,509	a 12,792,115	137,180,000
1873	34,720,000	6,720,000	9,721,000	1911	1,097,232,749	17,073,240	137,154,000
1874	39,200,000	4,480,000	8,624,000	1912	1,243,268,720	146,035,971	205,139,000
1875	40,320,000	1,120,000	9,152,000	1913	1,224,484,098	a 18,784,622	189,795,000
1876	42,560,000	2,240,000	8,937,000	1914	1,150,137,192	a 74,346,906	152,968,000
1877	47,040,000	4,480,000	8,937,000	1915	1,388,009,527	237,872,335	242,902,000
1878	48,160,000	1,120,000	7,994,000	1916	1,927,850,548	539,841,021	474,288,000
1879	51,520,000	3,360,000	9,582,000	1917	1,886,120,721	a 41,729,827	514,911,000
1880	60,480,000	8,960,000	12,943,000	1918	1,908,533,595	22,412,874	471,406,000
1881	71,680,000	11,200,000	13,046,000				
1882	90,646,232	18,966,232	17,313,000		27,106,589,103	....	4,634,321,000

a Decrease.

The figures in this table, except those for 1918, are taken from the volumes of Mineral Resources of the United States. Statistics from 1882 to 1918, inclusive, are based on the returns to the United States Geological Survey by the copper-producing companies. Figures for the years prior to 1882 were compiled by the Survey from the best sources available. Reliable figures for years prior to 1845 are not obtainable. The year 1845, however, marks the entrance of the Lake Superior district into the ranks of producers and is really the beginning of important production of copper in this country. The industry has shown a steady and, since 1880 when Arizona and Montana became large producers, a very rapid growth.

The figures of smelter production in 1918 are based on returns made confidentially to the United States Geological Survey by all known smelting companies handling copper-bearing materials from the United States. To all companies and officials who have aided in furnishing this information and have given valuable time to answering inquiries concerning distribution of the output sincere thanks are extended. The following list gives the name of the owning or operating companies, the location, and the final copper product of smelting and refining plants treating material from the United States during 1918. It does not include lead and zinc plants that recovered copper as a by-product from mixed ores. Lists of lead and zinc smelters can be found in the reports on those metals.

Copper reduction plants that treated materials from the United States in 1918.

Location.	Company.	Final copper product.
Arizona:		
Ajo	New Cornelia Copper Co	Electrolytic.
Clifton	Arizona Copper Co	Blister.
Do	Shannon Copper Co	Do.
Douglas	Calumet & Arizona Mining Co	Do.
Do	Phelps Dodge Corporation	Do.
Globe	Old Dominion Copper Mining & Smelting Co	Do.
Hayden	American Smelting & Refining Co	Do.
Humboldt	Consolidated Arizona Smelting Co	Do.
Clarkdale	United Verde Copper Co	Do.
Do	United Verde Extension Mining Co	Do.
Miami	International Smelting & Refining Co	Do.
Morenci	Phelps Dodge Corporation	Do.
Sasco	American Smelting & Refining Co	Do.
California:		
Campo Seco	Penn Mining Co	Do.
Kennett	United States Smelting, Refining & Mining Co	Do.
Martinez	Mountain Copper Co	Do.
Colorado:		
Salida	Ohio & Colorado Smelting & Refining Co	Matte.
Maryland:		
Baltimore	Baltimore Copper Smelting & Rolling Co	Electrolytic.
Michigan:		
Hancock	Lake Superior Smelting Co	Anodes and lake.
Do	Quincy Mining Co	Do.
Houghton	Michigan Smelting Co	Do.
Hubbell	Calumet & Hecla Mining Co	Do.
Montana:		
Anaconda	Anaconda Copper Mining Co	Blister.
Butte	East Butte Copper Mining Co	Do.
Great Falls	Anaconda Copper Mining Co	Blister and electrolytic.
Nebraska:		
Omaha	American Smelting & Refining Co	Blister.
Nevada:		
McGill	Nevada Consolidated Copper Co	Do.
Thompson	Mason Valley Mines Co	Do.
New Jersey:[a]		
Chrome	United States Metals Refining Co	Electrolytic and casting.
Maurer	American Smelting & Refining Co	Electrolytic.
Newark	Balbach Smelting & Refining Co	Electrolytic and casting.
Perth Amboy	Raritan Copper Works	Electrolytic.
New Mexico:		
San Pedro	Santa Fe Gold & Copper Mining Co	Matte.
New York:		
Laurel Hill	Nichols Copper Co	Electrolytic and casting.

[a] This list does not include a smelter in New Jersey and one in Pennsylvania, both of which make blister from material solely of foreign origin.

Copper reduction plants that treated materials from the United States in 1918—Contd.

Location.	Company.	Final copper product.
Tennessee:		
Copperhill	Tennessee Copper Co.	Blister.
Isabella	Ducktown Sulphur, Copper & Iron Co. (Ltd.)	Matte.
Texas:		
El Paso	American Smelting & Refining Co.	Blister.
Utah:		
Garfield	Garfield Smelting Co.	Do.
International	International Smelting & Refining Co.	Do.
Virginia:		
West Norfolk	Norfolk Smelting Co.	Do.
Washington:		
Tacoma	Tacoma Smelting Co.	Blister and electrolytic.
British Columbia:		
Anyox	Granby Consolidated Mining, Smelting & Power Co.	Blister.
Grand Forks	do.	Do.
Do.	do.	Do.
Greenwood	Canada Copper Corporation (Ltd.)	Do.
Trail	Consolidated Mining & Smelting Co. of Canada.	Blister and electrolytic.

During the year 46 copper smelting and refining plants treated material from the United States; of these, 41 were domestic plants and 5 were foreign.

The figures of production represent the actual smelter recovery. For Michigan it is the sum of furnace-refined copper and copper cast into anodes for electrolytic refining. As to blister copper, the figures represent the fine copper content. Some casting and electrolytic copper is produced direct from ore or matte, and this is included in the smelter production.

MINE RETURNS.

The figures of mine production are based on reports furnished to the United States Geological Survey by all mines producing copper in 1918. These mines reported 1,910,022,841 pounds of copper, or 1,489,246 pounds more than the smelters. The mines and smelters of several of the large copper producers are under the same management, and their production is reported on the same basis. The figures furnished by mines that ship to custom smelters or have only matting furnaces and ship their matte for conversion are likely to show considerable discrepancy from the smelter returns, as the mines may report a considerable quantity that has not reached the stage of blister copper by the end of the year and is consequently not included in the smelter production, or material that was reported by the mines in one year may be treated by the smelters in the following year. This discrepancy is more pronounced if a marked curtailment of production occurs at the beginning or the end of the year, so that there is not the balance of overlap that occurs if the industry is in normal condition throughout the year. Considerable copper is recovered by the smelters from ores that are treated primarily for other metals, the copper content being so low that it is not paid for and consequently is not always reported by the mines.

Copper produced from domestic ores as reported by mines, smelters, and refineries, 1906 1918, in pounds.

Year.	Mine.	Smelter.	Refinery.
1906	916,971,387	917,805,682	897,382,387
1907	847,151,015	868,996,491	826,622,390
1908	956,840,578	942,570,721	919,111,414
1909	1,126,521,126	1,092,951,624	1,065,564,921
1910	1,088,237,432	1,080,159,509	1,071,894,876
1911	1,114,764,197	1,097,232,749	1,101,270,803
1912	1,249,094,391	1,243,268,720	1,203,676,895
1913	1,235,569,727	1,224,484,098	1,236,823,913
1914	1,148,431,437	1,150,137,192	1,210,423,189
1915	1,488,071,528	1,388,009,527	1,387,705,523
1916	2,005,875,312	1,927,850,548	1,888,752,199
1917	1,895,434,349	1,886,120,721	1,873,546,171
1918	1,910,022,341	1,908,533,595	1,882,874,191

The difference between the smelter and the refinery production is accounted for entirely by an increase in the stocks of blister copper plus the copper content of bluestone produced and the loss in refining.

It appears that although theoretically the output reported by the mines should be considerably in excess of that reported by the smelters, this difference in the last 11 years has been nearly balanced by copper recovered from lead, zinc, gold, silver, and sulphur ores, which carry so little copper that it is not paid for and consequently has not usually been reported by the mines.

PRODUCTION BY STATES.

Twenty-two States and Territories contributed to the smelter production of copper in 1918. The subjoined table shows the mine and the smelter output of individual States for 1917 and 1918.

According to smelter returns, the four leading States—Arizona, Montana, Michigan, and Utah—produced 82 per cent of the total output in 1918, as compared with 79 per cent in 1917; and the eight leading States, including Nevada, New Mexico, Alaska, and California produced 98.09 per cent of the total output in 1918.

Copper produced in the United States in 1917 and 1918 according to smelter and mine returns, in pounds.

State.	1917		1918			
			Smelter returns.			
	Smelter returns.	Mine returns.	Rank.	Percentage of total.	Quantity.	Mine returns.
Alaska	84,759,086	88,793,400	7	3.51	67,081,648	69,224,951
Arizona	719,035,514	712,166,891	1	40.32	769,521,729	764,855,874
California	44,933,846	48,153,139	8	2.31	44,150,761	47,674,660
Colorado	10,054,951	8,122,004	10	.40	7,591,570	6,277,332
Georgia	930,691	930,691	17	.02	397,078	397,078
Idaho	6,446,224	7,827,574	11	.31	5,836,795	6,533,888
Maine	34,872	30,406	16	.02	501,169	766,000
Michigan	268,508,091	255,710,128	3	12.11	231,096,158	226,794,139
Missouri	407,141	365,013	18	.01	232,073	577,665
Montana	276,225,977	274,462,574	2	17.10	326,426,761	323,174,850
Nevada	115,028,161	122,794,704	5	5.57	106,266,603	116,316,441
New Mexico	107,593,615	105,568,000	6	5.06	96,559.580	98,264,563

Copper produced in the United States in 1917 and 1918 according to smelter and mine returns, in pounds—Continued.

State.	1917		1918			
	Smelter returns.	Mine returns.	Smelter returns.			Mine returns.
			Rank.	Percentage of total.	Quantity.	
North Carolina	125,004	124,991	19	....	79,200	....
Oregon	1,105,097	2,474,487	12	.14	2,630,499	2,451,016
Pennsylvania, Maryland, and Virginia	553,413	787,331	20	....	[a] 35,748	[b] 779,393
South Carolina	210,000	....	....	....	....	....
South Dakota	....	10,707	....	....	....	64,806
Tennessee	16,093,757	16,033,749	9	.79	15,053,568	14,799,680
Texas	2,061,129	23,132	21	....	13,851	9,308
Utah	227,840,447	246,674,153	4	12.10	230,964,908	227,169,630
Vermont	102,522	153,900	14	.05	896,630	1,116,384
Washington	2,051,416	2,199,518	13	.12	2,330,568	1,922,406
Wyoming	2,019,767	2,027,857	15	.05	866,698	852,777
	1,886,120,721	1,895,434,349	....	....	1,908,533,595	1,910,022,841

[a] Pennsylvania and Virginia. No smelter output for Maryland in 1918.
[b] Pennsylvania alone. No production for mines of Maryland and Virginia in 1918.

In the distribution of the blister output to the States of origin it is necessary to have reports not only from blister producers but also from matte smelters, as the matte is credited by the smelter that converts it to the State from which it was received, although the matte smelter may have received its ores from several States. In the adjustment of the products of these matte smelters slight errors in the distribution of the blister production are probably introduced. Likewise, the distribution of copper derived from zinc residues is subject to some error.

The following table shows the production from 1909 to 1918. The report for 1915 contains a table showing the production of copper by the different States from 1845.

Copper produced in the United States, 1909–1918, in pounds.

[Smelter output.]

State.	1909	1910	1911	1912	1913
Alaska	4,057,142	4,311,026	22,314,889	31,926,209	23,423,070
Arizona	291,110,298	297,250,538	303,202,532	359,322,096	404,278,809
California	53,568,708	45,760,200	35,835,651	31,516,471	32,492,265
Colorado	11,485,631	9,307,497	9,791,861	7,963,520	9,052,104
Idaho	7,096,132	6,877,515	4,514,116	7,182,185	8,711,490
Michigan	227,005,923	221,462,984	218,185,236	231,112,228	155,715,286
Montana	314,900,279	283,078,516	271,816,098	308,794,483	285,724,467
Nevada	53,849,281	64,494,640	65,561,015	83,413,900	85,209,536
New Mexico	5,031,136	3,784,609	2,860,400	29,170,400	50,196,881
Oregon	245,403	22,022	125,943	311,960	77,812
Utah	101,241,114	125,185,455	142,340,215	132,150,052	148,057,450
Washington	120,611	65,021	195,503	1,069,938	732,742
Wyoming	433,672	217,127	130,499	25,080	362,235
Other States and unapportioned	22,806,294	18,342,359	20,358,791	19,310,298	20,449,951
	1,092,951,624	1,080,159,509	1,097,232,749	1,243,268,720	1,224,484,096

Copper produced in the United States, 1909–1918, in pounds—Continued.

State.	1914	1915	1916	1917	1918
Alaska	24,985,847	70,695,286	113,823,064	84,759,086	67,081,648
Arizona	382,449,922	432,467,690	694,847,307	719,035,514	769,521,729
California	29,784,173	37,658,444	43,400,376	44,933,846	44,150,761
Colorado	7,316,066	7,272,178	9,536,193	10,054,951	7,591,570
Idaho	5,875,205	6,217,728	7,248,794	6,446,224	5,836,795
Michigan	158,009,748	238,956,410	269,794,531	268,508,091	231,096,158
Montana	236,805,845	268,263,040	352,139,768	276,225,977	326,426,761
Nevada	60,122,904	67,757,322	100,816,724	115,028,161	106,266,603
New Mexico	64,204,703	62,817,234	79,863,439	107,593,615	96,559,580
Oregon	5,599	797,471	2,433,567	1,105,097	2,630,499
Utah	160,589,660	175,177,695	232,335,950	227,840,447	230,964,908
Washington	683,602	903,661	2,473,481	2,051,416	2,330,568
Wyoming	17,082	351,871	1,784,351	2,019,767	866,698
Other States and unapportioned	19,286,836	18,673,497	17,352,503	20,518,529	17,209,317
	1,150,137,192	1,388,009,527	1,927,850,548	1,886,120,721	1,908,533,595

Copper produced in the United States, 1845–1918.

State.	Quantity (pounds).	Percentage.	Rank.
Alaska	475,820,554	1.76	8
Arizona	7,256,256,178	26.77	2
California	744,907,444	2.75	6
Colorado	274,837,414	1.01	9
Idaho	106,590,221	.39	10
Michigan	6,529,382,016	24.09	3
Montana	7,657,889,645	28.25	1
Nevada	822,115,262	3.03	5
New Mexico	585,589,415	2.16	7
Oregon	9,937,632	.03	13
Utah	2,108,536,950	7.78	4
Washington	12,418,092	.05	12
Wyoming	31,400,983	.12	11
Other States and unapportioned	490,906,697	1.81	7
	27,106,589,103	100.00	....

The figures in the first column of the preceding table show the copper output of each important copper-producing State since the beginning of the industry. Some copper was produced in New Mexico in the early years of the last century, but the exact quantity is not known, though it was not large as measured by the present production of the metal. Prior to 1845 also a little copper was produced in Michigan and a considerable quantity in the Eastern States.

Under "Other States and unapportioned" is included some copper assigned to "lead desilverizers" in the earlier reports of the Survey. This should properly be credited to some of the Western States. The output of the Central States, except Michigan, is also included under this head. Statistics for the individual Eastern States have not been compiled, but it may be stated that about 351,000,000 pounds has been derived from Tennessee. To the remainder Vermont and Virginia have made the largest contributions, and some copper has been produced by practically all the Appalachian States.

Montana, Arizona, and Michigan stand out as the three chief copper-producing States. Montana ranks first, with 28 per cent of the entire output of the country; Arizona ranks second, with nearly 27 per cent; and Michigan ranks third, with 24 per cent. The three leading States have produced 79 per cent of the total. Utah, ranking next in order, has produced about 8 per cent of the total output.

Mine production of copper in the principal districts in 1918.

District or region.	State.	Mine output (pounds).	Percentage of total production.	Rank.
Butte	Montana	321,104,000	16.81	1
Lake Superior	Michigan	226,794,000	11.87	2
Bingham	Utah	211,195,000	11.06	3
Globe-Miami	Arizona	201,806,000	10.57	4
Bisbee (Warren)	.....do	160,456,000	8.40	5
Jerome	.....do	133,781,000	7.00	6
Ely (Robinson)	Nevada	92,420,000	4.84	7
Ray (Mineral Creek)	Arizona	86,126,000	4.51	8
Santa Rita (Central)	New Mexico	77,547,000	4.06	9
Morenci-Metcalf	Arizona	71,867,000	3.76	10
Copper River	Alaska	52,541,000	2.75	11
Ajo	Arizona	46,950,000	2.46	12
Shasta County	California	25,030,000	1.31	13
Yerington	Nevada	17,139,000	.90	14
Burro Mountain	New Mexico	17,100,000	.90	15
Prince William Sound	Alaska	15,311,000	.80	16
Ducktown	Tennessee	14,800,000	.77	17
Pioneer	Arizona	12,332,000	.65	18
Plumas County	California	11,192,000	.58	19
Big Bug	Arizona	7,936,000	.42	20
Silver Bell	.....do	7,829,000	.41	21
Foothill Belt	California	6,937,000	.36	22
Tintic	Utah	6,569,000	.34	23
Banner	Arizona	5,830,000	.31	24
Courtland (Turquoise)	.....do	4,366,000	.23	25
Cochise	.....do	4,174,000	.22	26
Patagonia	.....do	4,029,000	.22	27
Alder Creek	Idaho	3,504,000	.18	28
Pima	Arizona	3,032,000	.16	29
Coeur d'Alene region	Idaho	2,707,000	.14	30
Beaver County	Utah	2,636,000	.14	31
Agua Fria	Arizona	2,495,000	.13	32
Copper Basin	.....do	2,343,000	.12	33
Lordsburg	New Mexico	2,215,000	.12	34
Peck	Arizona	2,214,000	.12	35
Helvetia	.....do	2,156,000	.11	36
Battle Mountain	Nevada	1,999,000	.10	37
Santa Fe	.....do	1,923,000	.10	38
San Francisco	Utah	1,805,000	.09	39
Planet	Arizona	1,743,000	.09	40
Ophir	Utah	1,669,000	.09	41
Baker County	Oregon	1,655,000	.09	42
Leadville	Colorado	1,620,000	.08	43
Little Cottonwood	Utah	1,560,000	.08	44
Ketchikan	Alaska	1,372,000	.07	45
San Bernardino County	California	1,351,000	.07	46
San Juan-Ouray	Colorado	1,273,000	.07	47

As shown in this table, 47 districts in 1918 each produced 1,000,000 pounds or more of copper.

In the following table the statistics for the later years are compiled from reports furnished to the United States Geological Survey by the producing companies and those for the earlier years are taken mainly from reports on the several districts by members of the Survey:

Blister copper produced in the principal districts to the end of 1918.

District.	State.	Date production began.	Quantity (pounds).	Percentage of total production.	Rank.
Butte	Montana	1868	7,621,600,000	28.12	1
Lake Superior	Michigan	1845	6,512,281,500	24.02	2
Bisbee	Arizona	1880	2,547,611,000	9.40	3
Bingham	Utah	1896	1,809,713,000	6.68	4
Morenci-Metcalf	Arizona	1873	1,422,063,000	5.25	5
Globe-Miami	.....do	1881	1,274,496,000	4.70	6
Jerome	.....do	1883	1,135,120,000	4.19	7
Ely (Robinson)	Nevada	1908	720,164,000	2.66	8
Shasta County	California	1897	565,679,000	2.09	9
Santa Rita (Central)	New Mexico	1800	532,886,300	1.97	10
Ray (Mineral Creek)	Arizona	1911	474,804,000	1.75	11
Ducktown	Tennessee	1850	351,112,000	1.29	12
Foothill belt	California	1862	150,796,000	.56	13
Tintic	Utah	1880	146,525,000	.54	14

Fourteen districts in eight States have each contributed in excess of 100,000,000 pounds to the copper output of the country. Five of these districts are in Arizona, 2 each in California and Utah, and 1 each in Montana, Michigan, Nevada, New Mexico, and Tennessee. Two districts stand out prominently. They are the Butte district, Montana, which has produced 28 per cent of the output of the country, and the Lake Superior district, Michigan, which has produced 24 per cent of the total output. Bisbee, ranking third, has yielded 9.40 per cent of the total. The 14 districts have yielded 93 per cent of the total output of the United States since 1845.

It is noteworthy that not a single one of the leading copper districts of the United States, several of which have been active producers for a period of 30 years or more, has been worked out or has shown a decrease in its ability to produce copper.

QUANTITY AND YIELD OF COPPER ORES.

COPPER-BEARING ORES PRODUCED.

The following tables show the quantity and the yield in copper of the ore produced by the mines of the United States in 1918. The figures are taken from the mines reports which form parts of the annual volume Mineral Resources. The close agreement between the output as reported by the mines and the actual recovery of metal as reported by the smelters indicates that the tenor of the ores as reported by the mines is very close to the actual recovery. The classification of some of the complex western ores is difficult and more or less arbitrary. Under copper ores are classed those which contain 2.5 per cent or more of copper, as well as those which contain less than this percentage, provided their principal value is in copper.

Under copper-lead and copper-zinc ores are classed complex ores in which copper is a valuable constituent. Considerable copper was reported by the mines from ores mined primarily for other metals, including siliceous gold and silver ores, lead ores, zinc ores, pyritic sulphur ores, and ores concentrated for their content of other metals. No attempt had been made to compile tables showing the quantity and yield of this group of copper-bearing ores, but together with old slags and other materials they have yielded a total of 24,875,991 pounds of copper.

Copper produced in the United States in 1918 from ore in which copper is the most valuable constituent.

State.	Copper ore.	Copper in ore.		Gold in ore.	Silver in ore.	Value in gold and silver per ton.
		Quantity.	Percentage.			
	Short tons.	*Pounds.*		*Fine ounces.*	*Fine ounces.*	
Alaska	722,047	69,224,951	4.79	5,206.84	719,391	$1.07
Arizona	18,647,039	763,766,399	2.05	108,750.43	5,347,618	.41
California	908,059	46,863,338	2.58	15,443.97	669,711	1.09
Colorado	18,088	1,668,087	4.61	1,968.68	166,296	11.44
Georgia	14,960	397,078	1.33	....	....	....
Idaho	127,898	5,389,887	2.11	3,339.71	262,991	2.59
Maine	25,343	766,000	1.51	32.99	6,338	.36
Michigan	11,321,365	226,794,139	1.00	....	509,467	.18
Montana	6,412,941	316,740,920	2.47	32,464.51	10,521,219	1.75
Nevada	4,994,804	116,109,020	1.16	49,186.44	278,615	.26
New Mexico	4,516,407	97,101,342	1.08	11,698.51	251,329	.11
Oregon	37,956	2,451,016	3.23	4,199.10	26,161	2.97
Pennsylvania	363,975	779,393	.11	....	....	....

Copper produced in the United States in 1918 from ore in which copper is the most valuable constituent—Continued.

State.	Copper ore.	Copper in ore.		Gold in ore.	Silver in ore.	Value in gold and silver per ton.
		Quantity.	Percentage.			
	Short tons.	*Pounds.*		*Fine ounces.*	*Fine ounces.*	
South Dakota	637	64,806	5.09	1.55	256	$0.45
Tennessee	529,012	14,799,680	1.40	235.39	93,620	.18
Texas	39	9,308	11.93	.70	57	1.83
Utah	13,512,274	217,252,784	.80	75,960.07	1,445,559	.22
Vermont	49,772	1,116,384	1.12	4.02	3,440	.07
Washington	83,583	1,907,565	1.14	463.82	149,858	1.91
Wyoming	2,870	852,777	14.86	42.14	965	.64
Total and average	62,289,069	1,884,054,874	1.51	308,998.87	20,452,891	.50

Copper ores concentrated, smelted, and leached and copper produced from each class of ore in the United States in 1918.

State.	Ore concentrated.			
	Quantity.	Concentrates produced.	Copper in concentrates.	Percentage of copper.
	Short tons.	*Short tons.*	*Pounds.*	
Alaska	616,103	78,386	43,397,348	3.52
Arizona	13,097,104	854,714	328,119,258	1.25
California	541,507	50,917	18,540,953	1.71
Idaho	69,635	3,572	1,142,884	.82
Maine	25,343	3,555	766,000	1.51
Michigan	11,321,365	[a] 182,418	[b] 226,794,139	1.00
Montana	5,960,432	1,738,462	279,192,383	2.34
Nevada	4,532,948	530,843	85,886,971	.95
New Mexico	4,455,133	353,761	92,608,753	1.04
Oregon	33,583	6,734	1,602,145	2.39
Pennsylvania	363,975	12,834	779,393	.11
Utah	12,798,317	631,753	193,819,955	.76
Vermont	49,772	3,504	1,116,384	1.12
Washington	72,579	4,186	1,110,258	.77
Total and average	53,937,796	4,455,639	1,274,876,824	1.18

State.	Ore leached.[c]			Ore smelted.		
	Quantity.	Copper produced.	Percentage of copper.	Quantity.	Copper produced.	Percentage of copper.
	Short tons.	*Pounds.*		*Short tons.*	*Pounds.*	
Alaska				105,944	25,827,603	12.19
Arizona	1,776,000	42,310,700	1.19	3,773,935	393,336,441	5.21
California				366,552	28,322,385	3.86
Colorado				18,088	1,668,087	4.61
Georgia				14,960	397,078	1.33
Idaho				58,263	4,247,003	3.64
Montana	68,502	2,350,352	1.72	384,007	35,198,185	4.58
Nevada	203	12,364	3.05	461,653	30,209,685	3.27
New Mexico				61,274	4,492,589	3.67
Oregon				4,373	848,871	9.71
South Dakota				637	64,806	5.09
Tennessee				529,012	14,799,680	1.40
Texas				39	9,308	11.93
Utah	282,894	3,023,028	.53	431,063	20,409,801	2.37
Washington				11,004	797,307	3.62
Wyoming				2,870	852,777	14.86
Total and average	2,127,599	47,696,444	1.13	6,228,674	561,481,606	4.51

[a] Includes concentrates from sands.
[b] Includes copper from sands.
[c] Does not include old tailings treated.

Copper produced from copper-lead and copper-zinc ores in the United States in 1918.

State.	Copper-lead and copper-zinc ores.	Copper in ore.	Percentage of copper.
	Short tons.	*Pounds.*	
Arizona	916	90,374	4.9
California	297	26,113	4.4
Colorado	1,760	138,132	3.9
Idaho	105	11,126	5.3
Montana	253	10,086	1.9
Nevada	800	63,410	3.9
New Mexico	4,072	533,259	6.5
Utah	7,495	219,476	1.5
Total and average	15,698	1,091,976	3.5

Copper derived from ores classed as copper-bearing (copper, copper-lead, and copper-zinc ores), and total production of copper from all sources in the United States in 1918.

State.	Ore treated.	Copper recovered.	Percentage of copper.	Copper from all sources including old slags, smelter cleanings, and precipitates.
	Short tons.	*Pounds.*		*Pounds.*
Alaska	722,047	69,224,951	4.79	69,224,951
Arizona [a]	18,647,955	763,856,773	2.05	764,855,874
California	908,356	46,889,451	2.58	47,674,660
Colorado [b]	19,848	1,806,219	4.55	6,277,332
Georgia	14,960	397,078	1.33	397,078
Idaho	128,003	5,401,013	2.11	6,533,888
Maine	25,343	766,000	1.51	766,000
Michigan	11,321,365	226,794,139	1.00	226,794,139
Missouri	....	....	....	577,665
Montana [c]	6,413,194	316,751,006	2.47	323,174,850
Nevada	4,995,604	116,172,430	1.16	116,316,441
New Mexico [d]	4,520,479	97,634,601	1.08	98,264,563
Oregon	37,956	2,451,016	3.23	2,451,016
Pennsylvania	363,975	779,393	.11	779,393
South Dakota	637	64,806	5.09	64,806
Tennessee	529,012	14,799,680	1.40	14,799,680
Texas	39	9,308	11.93	9,308
Utah	13,519,769	217,472,260	.80	227,169,630
Vermont	49,772	1,116,384	1.12	1,116,384
Washington	83,583	1,907,565	1.14	1,922,406
Wyoming	2,870	852,777	14.86	852,777
Total and average	62,304,767	1,885,146,850	1.51	1,910,022,841

[a] Considerable copper was recovered from old slags and ores not classed as copper ores.

[b] Most of the copper from Colorado is derived from ores classed as siliceous ores and lead ores.

[c] Considerable copper was recovered as precipitates from mine waters and from ore not classed as copper ores.

[d] A large quantity of copper was derived from ores classed as lead ores, lead-zinc ores, and siliceous ores.

Copper ores produced in the United States, 1906–1918, and average yield in copper, gold, and silver.

Year.	Copper ores.	Yield in copper.	Yield per ton in gold.	Yield per ton in silver.	Value per ton in gold and silver.
	Short tons.	*Per cent.*	*Ounce.*	*Ounce.*	
1906	18,000,000	2.50	0.0150	0.882	$0.856
1907	20,253,000	2.11	.0135	.609	.682
1908	[a] 22,290,886	2.07	.0104	.666	.560
1909	27,932,618	1.98	.0097	.655	.540
1910	28,497,238	1.88	.0093	.562	.495
1911	29,988,235	1.82	.0089	.555	.492
1912	35,656,414	1.71	.0073	.517	.468
1913	36,336,682	1.67	.0057	.502	.420
1914	[b] 35,175,541	1.60	.0075	.422	.39
1915	43,404,182	1.66	.0078	.428	.38
1916	57,863,365	1.70	.0069	.424	.42
1917	58,482,694	1.60	.0058	.347	.49
1918	62,289,069	1.51	.0050	.328	.50

[a] Includes 143,675 tons of slag smelted.

[b] Includes 99,816 tons of slag smelted and ore leached.

Copper ores produced in the United States, 1906–1918, classified as smelting and concentrating ores, and average yield in copper.

Year.	Smelting ores.		Concentrating ores.	
	Quantity.	Yield in copper.	Quantity.	Yield in copper.
	Short tons.	*Per cent.*	*Short tons.*	*Per cent.*
1906	3,278,000	....	14,722,000	....
1907	3,957,500	4.05	16,295,500	1.41
1908	4,386,689	4.27	17,760,522	1.485
1909	5,267,707	4.15	22,664,911	1.47
1910	5,001,394	4.14	23,495,844	1.40
1911	4,355,650	4.66	25,632,585	1.34
1912	5,014,018	4.45	30,642,396	1.26
1913	5,290,310	4.22	31,046,372	1.22
1914	4,597,398	4.23	30,478,327	1.20
1915	5,433,907	4.60	37,970,275	1.26
1916	6,928,010	4.72	50,935,355	1.28
1917	7,438,068	4.39	51,044,626	1.19
1918	6,223,674	4.51	53,937,796	1.18

The output of copper-bearing ores in 1918 showed an increase over that of any preceding year. For the last 13 years there has been a steady increase in production of these ores except in 1914, when there was a slight decrease. Arizona is the largest producer of copper ore, followed in order by Utah, Michigan, Montana, Nevada, New Mexico, California, Alaska, and Tennessee. In the output of smelting ore Arizona is first, followed by Tennessee, Nevada, Utah, Montana, California, Alaska, New Mexico, and Idaho. In the output of concentrating ore Arizona is first, followed by Utah, Michigan, Montana, Nevada, New Mexico, and Alaska.

YIELD OF COPPER FROM ORES.

The average yield of copper from copper ore in 1918 was 1.51 per cent. There was a steady decrease in the average yield of copper from copper ores from about 2.50 per cent in 1906 to 1.60 per cent in 1914. The yield showed an increase in 1915 and 1916, but it was less again in 1917 and 1918. The decrease from 1906 to 1914 may be taken as a general measure of the improvement in metallurgic practice that has made possible the treatment of lower-grade material. The increase in 1915 and 1916 was doubtless due mainly to the increase in the recovery of copper resulting from the introduction of improved methods, notably the flotation process. The decrease in 1917 and 1918 was due partly to operation of the plants beyond their capacity for best metallurgic results.

The average yield from direct smelting ores has increased from 4.05 per cent in 1907 to 4.51 per cent in 1918; that from concentrating ores decreased from 1.48 per cent in 1908 to 1.20 per cent in 1914, increased to 1.28 per cent in 1916 owing to improved metallurgic processes, but decreased to 1.18 per cent in 1918.

Of the important copper-producing States Alaska produced the highest grade of copper ore in 1918, followed in order by California, Montana, Arizona, Tennessee, Nevada, New Mexico, Michigan, and Utah. Of the States producing smelter ore in large quantity Alaska had the highest yield, followed by Arizona, Montana, California, Nevada, Utah, and Tennessee.

Of the States producing concentrating ores in large quantity Alaska had the highest grade, followed by Montana, California, Arizona, New Mexico, Michigan, Nevada, and Utah.

The average recovery of gold and silver from copper ores shows a variation about in proportion to that of copper. In 1906 copper ores averaged 85.6 cents to the ton in gold and silver; in 1918 the average yield was 50 cents to the ton. Among the principal copper-producing States Montana was first in the average yield of gold and silver per ton of ore, followed by California, Alaska, Arizona, Nevada, Utah, Michigan, Tennessee, and New Mexico.

REVIEW BY STATES.

SCOPE OF DISCUSSION.

In the following pages a brief statement of the conditions affecting production in the principal copper districts of the country is presented, and the tenor of the ore from each district is given, so far as it does not disclose the production of those individual companies whose figures of output have not already been published in their annual reports or elsewhere. Those who desire more detailed information on the mining operations of the districts are referred to the reports on mine production in the several States, which form other chapters of Mineral Resources, as set forth in the prefatory note.

Figures of metal output, ore reserves, metal content, and recovery in treatment of individual companies given in this report, unless otherwise stated, are quoted from the official reports of the companies.

The report for 1915 contains a map showing the location of the copper-producing districts and the metallurgic plants and also a brief discussion of the geologic occurrence of the ores in the different districts. Copies of that report may be obtained on application to the Director of the United States Geological Survey.

ALASKA.

The production of blister copper from Alaska in 1918 was 67,081,648 pounds, as compared with 84,759,086 pounds in 1917. The mine production of copper in 1918 was 69,224,951 pounds.

Alaska began to produce copper in notable quantity about 1903, and since that time it has been a steady contributor. Its total production of blister copper to the end of 1918 is 475,820,554 pounds. The output in 1918 came from the Ketchikan, Prince William Sound, and Copper River districts.

Ketchikan district.—Copper mining in the Ketchikan district was active in 1918. The mines yielded 21,683 tons of ore, from which 1,372,347 pounds of copper was produced.

The It mine, at Kasaan Bay, was operated by the Granby Consolidated Mining Co. For the fiscal year ending June 30, 1918, it produced 11,776 tons of ore having an average assay content of 4.89 per cent of copper.

Reserves as of June 30, 1918, were reported as 2,500 tons averaging 5 per cent of copper.

The Mamie mine was operated by the same company, which shipped from it 3,102 tons of ore averaging 1.96 per cent copper.

Ore reserves as of June 30, 1918, were given as 115,226 tons, averaging 1 per cent copper.

Prince William Sound district.—Copper mining in the Prince William Sound district in 1918 was active and the output was one of the largest made by this district. The ores of the district were shipped to the Tacoma and Anyox smelters. The largest producer was the Beatson-Bonanza mine, but the Ellamar and other copper properties shipped ore.

Copper mines produced 435,826 tons of ore yielding 15,311,590 pounds of copper, 118,329 ounces of silver, and 3,842 ounces of gold.

There was mined from the Beatson mine of the Kennecott Copper Corporation 397,851 tons of ore, averaging 2.02 per cent of copper. The ore milled during the year amounted to 395,524 tons, averaging 2 per cent of copper. Concentrates amounted to 49,915 tons, averaging 12.80 per cent of copper. The average recovery was 80.70 per cent.

Copper River district.—The Bonanza and Jumbo mines of the Kennecott Copper Corporation were the largest producers in the Copper River district. The Mother Lode Copper Mines Co., of the Chitina district, also produced in 1918.

During the year there was mined from the Bonanza and Jumbo mines 262,377 tons of ore, averaging 10.59 per cent of copper; 218,819 tons of ore milled averaged 7.82 per cent of copper. Concentrates amounted to 27,174 tons, averaging 53 per cent. The average recovery was 84.19 per cent. The ammonia-leaching plant treated 132,304 tons of tailings, averaging 0.94 per cent of copper, with a recovery of 1,704,080 pounds of copper. The total average milling recovery for the year, including leaching-plant operations, was 89.17 per cent.

The total recovery from the Copper River and Beatson output was 60,994,757 pounds of refined copper and 684,779 ounces of silver.

Profit on metal sold and delivered by the Kennecott Copper Corporation amounted to $9,390,135, and total profits, including dividends on stock held by the company, amounted to $14,672,272.

Dividends were paid to the amount of $5,574,089, and in addition a capital distribution of $5,574,089 was made.

Developments were continued by the Mother Lode Copper Mines Co., and a small production was made. In a report dated August 1, 1917, W. B. Hancock, superintendent, gave the ore developed as 113,930 tons, containing 17,523 tons of copper. A controlling interest in the Mother Lode Mines Co. was acquired by the Kennecott Copper Corporation in 1918, and the mines will probably be operated with the mines of that group and the necessity for the construction of a new mill will be obviated.

ARIZONA.

In 1918 Arizona produced 769,521,729 pounds of blister copper, compared with 719,035,514 pounds in 1917.

The steady output of copper from Arizona began about 1875, though there had been intermittent production since 1862. Since 1880 the growth of the industry has been steady and rapid, and to the end of 1918 Arizona had a recorded production of 7,256,256,178 pounds of copper, or 26.77 per cent of the total output of the country, thus ranking second among the States. In 1918 Arizona produced 40.32 per cent of the total output. The greater part of the production came from five districts. Thirteen copper-smelting plants were operated within the State during the year.

Bisbee district.—Most of the ore occurs as irregular replacement bodies in limestone without any definite arrangement, and the cost of prospecting is consequently rather high. The irregular character of the ore deposits and the heavy ground, especially in the oxidized ore bodies, have resulted in relatively high cost of extraction.

In recent years large bodies of disseminated ore have been developed in the altered granite porphyry of Sacramento Hill.

Copper produced in Bisbee district, Ariz., 1906–1918.

Year.	Quantity.	Average yield in copper.	Value in gold and silver per ton.	Year.	Quantity.	Average yield in copper.	Value in gold and silver per ton.
	Pounds.	*Per cent.*			*Pounds.*	*Per cent.*	
1906	131,000,000	6+		1913	155,100,000	5.6	$1.16
1907	110,000,000	6+		1914	151,600,000	5.4	1.35
1908	129,000,000	6+		1915	164,600,000	5.0	1.66
1909	130,000,000	6+		1916	193,600,000	4.9	1.51
1910	142,500,000	5.4	$1.07	1917	167,600,000	5.0	1.56
1911	130,200,000	5.9	1.42	1918	160,456,000	4.9	1.62
1912	140,000,000	5.6	1.41				

The production of the Copper Queen branch of the Phelps Dodge Corporation, as summarized in the company's report, is as follows:

Metals produced by Copper Queen branch of Phelps Dodge Corporation, 1918.

Production of mines.

	Ore, dry weight.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Ounces.*	*Ounces.*	*Pounds.*	*Pounds.*
Shipped to Douglas	759,642	16,067	530,448	89,954,775	
Shipped to El Paso	3,471	336	27,777	75,703	1,234,497
Shipped to experimental concentrator	1,272				
Shipped to Chicago, manganese ore	5,058				
Precipitates	915		61	876,380	
Neptune slag	166		24	6,223	
Concentrates shipped	539	6	123	75,075	
	771,063	16,409	558,433	90,988,156	1,234,497

Production of reduction works.

	Ore, dry weight.	Gold.	Silver.	Copper.
	Short tons.	*Ounces.*	*Ounces.*	*Pounds.*
Copper Queen branch	789,827	16,545	484,706	89,645,341
Burro Mountain branch	50,874	212	42,578	14,940,891
Montezuma Copper Co.	190,160	8,374	810,545	43,042,928
All other	280,881	7,578	969,478	44,434,052
	1,311,742	32,709	2,307,307	192,063,212

Metals produced by Copper Queen Consolidated Mining Co., 1911–1918.

Year.	Ore.	Copper.	Silver.	Gold.	Lead.	Earnings.	Dividends.
	Short tons.	*Pounds.*	*Ounces.*	*Ounces.*	*Pounds.*		
1911	619,132	74,489,728	1,227,453	16,895	5,658,930	$4,155,010	$5,200,000
1912	786,368	88,280,908	1,027,130	18,023	2,953,685	6,977,378	5,707,351
1913	867,481	97,181,725	919,138	16,213	5,701,628	6,916,900	5,700,000
1914	732,829	86,066,143	1,036,672	15,769	8,889,175	6,042,001	4,500,000
1915	833,107	88,551,180	943,368	18,974	9,388,418		
1916	951,978	102,685,722	1,096,136	24,030	9,421,562		
1917	800,970	93,618,409	828,665	19,156	6,870,128		
1918	771,063	90,988,156	558,433	16,409	1,234,497		

Though the footage development in the limestone mines was slightly less than for 1917, it is stated that the ore reserves showed a most gratifying increase.

At the close of 1918 the overburden of the Sacramento Hill disseminated deposits had been 30.8 per cent removed.

The production of the Calumet & Arizona Mining Co. is shown in the following table:

Metals produced by Calumet & Arizona Mining Co., including the Superior & Pittsburgh Co. before the consolidation of the two, 1911–1918.

Year.	Company.	Ore smelted.	Copper produced.	Copper recovered.	Gold.	Silver.	Dividends.
		Short tons.	*Pounds.*	*Per cent.*	*Ounces.*	*Ounces.*	
1911	Calumet & Arizona	231,135	21,476,739	4.487	9,329	216,987	$1,969,059
	Superior & Pittsburgh	230,620	28,469,166	6.1859	8,785	236,960	1,739,758
1912	Calumet & Arizona	169,287	16,490,229	4.34	9,066	233,092	2,542,781
	Superior & Pittsburgh	318,418	36,618,399	5.762	13,815	361,227	1,919,733
1913	Calumet & Arizona	111,541	52,621,651	4.485	15,890	540,214	3,059,206
	Superior & Pittsburgh	376,568		5.785			
1914	Calumet & Arizona	540,468	49,992,909	4.62	19,744	578,606	1,851,008
1915	do	729,677	63,126,931	4.33	26,212	947,129	2,006,557
1916	do	845,286	70,702,028	4.17	31,673	1,267,734	5,777,296
1917	do		59,131,512		27,947	906,038	6,424,762
1918	do		50,909,373		31,308	906,210	5,140,062

The quantity of developed ore is reported to have been somewhat increased during the year.

At the reduction works at Douglas 850,894 tons of ore was treated. The sulphuric-acid plant produced an average of 186 tons of 60° Baumé acid per day, or a total of 67,110 tons for the year.

Net income for the year was $4,086,238. Regular dividends for the year amounted to $5,140,062. Total dividends to the close of 1918 amounted to $41,132,823.

The following table shows the results of operations of the Shattuck Arizona Copper Co.:

Metals produced by Shattuck Arizona Copper Co., 1911–1918.

Year.	Copper.	Silver.	Gold.	Lead.	Copper recovered.	Dividends.
	Pounds.	*Ounces.*	*Ounces.*	*Pounds.*	*Per cent.*	
1911 [a]	4,111,000					
1912 [b]	1,253,305	21,008	13		7.13	
1912 [c]	1,746,493	15,165	16		6.67	
1913	13,219,756	236,000	2,033	1,483,956	6.67	$525,000
1914	10,846,918	198,419	2,445	14,065	5.79	525,000
1915	11,154,211	201,869	3,151	2,345,342	5.89	875,000
1916	18,161,763	314,918	4,721	3,413,445	5.38	1,662,500
1917	11,935,317	154,344	1,542	2,010,145	4.57	[d] 612,500
1918	9,081,959	161,230	1,220	2,420,690	4.87	700,000

[a] Year ending August, 1911.

[b] Year ending August, 1912.

[c] Aug. 1 to Dec. 31, 1912, inclusive.

[d] Capital distribution to the amount of $1,137 500.

Mine and smelter production of Shattuck Arizona Copper Co., 1918.

	Copper ore.		Lead ore.	
	Wet.	Dry.	Wet.	Dry.
Tons ore stoped	93,617	86,504	28,356	27,691
Tons ore developed	7,971	7,358	1,637	1,586
Tons ore from dumps, etc	108	105	....	....
Tons ore mined	101,696	93,967	29,998	29,277
Tons ore shipped	101,727	93,995	29,819	29,106
Tons ore smelted	101,835	94,092	29,244	28,550

Copper recovered	pounds..	9,081,959
Gold recovered	ounces..	1,220
Silver recovered	do....	161,230
Lead recovered from concentrates	pounds..	1,907,426
Gold recovered from concentrates	ounces..	709
Silver recovered from concentrates	do....	66,592
Lead recovered, direct shipments	pounds..	513,264
Gold recovered, direct shipments	ounces..	132
Silver recovered, direct shipments	do....	6,103

Cost per pound of refined copper.

Gross operating cost	cents..	16.694
Less operating credits	do....	2.059
Net operating cost	do....	14.635

Globe-Miami district.—Production of copper began in the Globe district in 1881; the camp was well known as a silver producer before that date. For several years the production was intermittent, but since 1888, and especially since 1898, when the railroad reached the camp, the district has ranked among the large copper producers of the country. To the end of 1918 it has produced 1,274,496,000 pounds of blister copper, or 4.70 per cent of the output of the country since 1845. In total production the district ranks sixth in the country and third in the State; for 1918 it ranked fourth in the country and first in the State. The Miami part of the district made its first notable output in 1911.

Copper produced in Globe-Miami district, Ariz., 1906–1918.

Year.	Copper.	Yield of ore in copper.	Year.	Copper.	Yield of ore in copper.
	Pounds.	*Per cent.*		*Pounds.*	*Per cent.*
1906	27,000,000	3.4	1913	71,000,000	2.38
1907	35,000,000	4	1914	72,000,000	2.41
1908	36,000,000	4.5	1915	98,500,000	2
1909	33,000,000	4.43	1916	220,000,000	1.43
1910	27,600,000	5	1917	169,490,000	1.42
1911	44,600,000	3.35	1918	201,806,000	1.31
1912	61,600,000	2.21			

Ore produced by Old Dominion Co., 1918.

	Quantity (short tons).	Percentage of copper.
Smelting ore	72,588	6.54
Concentrating ore	153,166	3.59
Converting ore	4,697	3.76

Metals produced by Old Dominion Co., 1911–1918.

Year.	Ore.	Copper.	Gold.	Silver.	Average yield in copper.	Cost per pound of copper.	Dividends.
	Short tons.	*Pounds.*	*Ounces.*	*Ounces.*	*Per cent.*	*Cents.*	
1911	174,246	19,195,181	936	42,050	5.84	9.5	$486,000
1912	201,181	16,533,998	583	42,750	4.67	10.34	729,000
1913	169,961	18,945,153	419	51,316	5.88	9.7	810,000
1914	129,813	17,816,284	608	33,311	7.44	8.22	445,500
1915	115,459	13,771,681	620	40,632	6.56	8.90	1,053,000
1916	152,059	17,654,643	1,240	60,688	5.88	11.69	1,944,000
1917[a]	199,888	32,365,795	3,897	165,703	4.97	....	2,376,262
1918	230,451	33,378,158	5,071	184,982	4.52	....	1,188,284

[a] Includes custom ores.

Metals produced by United Globe mines, 1911–1916.

Year.	Ore.	Copper.	Silver.	Gold.	Yield in copper.	Dividends.
	Short tons.	*Pounds.*	*Ounces.*	*Ounces.*	*Per cent.*	
1911	110,578	8,525,433	111,459	876	3.85	....
1912	188,254	12,252,073	124,362	789	3.25	$460,000
1913	167,919	11,348,100	119,588	1,537	3.38	690,000
1914	155,205	11,086,674	91,582	1,580	3.57	425,500
1915	141,240	11,536,021	105,109	1,508	4.08	621,000
1916	206,163	14,852,399	128,066	1,543	3.60	1,679,000

Dividends paid by the Old Dominion Co. to December 31, 1918, amounted to $14,405,260.

Total dividends paid by the United Globe mines to the end of 1916 amounted to $4,255,000. In 1917 it was combined with the Old Dominion Co.

The smelters of the Old Dominion Co., at Globe, and of the International Smelting & Refining Co., at Miami, were operated throughout the year.

The district is served by the Arizona Eastern Railroad.

The Arizona Commercial Mining Co. produced 62,797 tons of ore, averaging 5.874 per cent of copper. The metal output was 6,076,303 pounds of copper, 15,981 ounces of silver, and 831 ounces of gold. The net income for the year was $113,246. A dividend of $530,000 was paid during the year.

The following tables show the operations of the Miami Copper Co.:

Copper produced by Miami Copper Co., 1911–1918.

Year.	Ore.	Copper content.	Mill extraction.	Refined copper.	Cost of copper per pound.	Dividends.
	Short tons.	*Per cent.*	*Per cent.*	*Pounds.*	*Cents.*	
1911	445,036	2.48	73.37	15,385,783	9.103	....
1912	1,040,744	2.393	69.39	32,832,609	9.5884	$1,100,112
1913	1,058,784	2.30	71.06	32,867,666	10.6086	1,491,989
1914	1,096,633	2.28	69.93	33,296,010	9.2045	1,120,375
1915	1,348,122	2.17	75.17	41,832,059	8.76	1,681,004
1916	1,842,017	2.07	73.88	53,518,331	9.52	4,295,905
1917	1,640,206	2.03	69.25	43,863,699	12.51	6,537,247
1918	2,132,941	2.026	71.15	58,407,563	14.833	3,362,013

Milling operations of Miami Copper Co., 1918.

Ore milled	short tons	2,132,941
Copper in ore	per cent	2.026
Concentrates produced	short tons	76,750
Copper in concentrates	per cent	40.147
Copper in concentrates	pounds	61,481,662
Copper recovered per ton of ore	do	28.82
Mill extraction	per cent	71.15

Cost of copper in concentrates f. o. b. cars at Miami, Ariz., 1918.

	Per ton of ore.	Per pound of copper.
Mining	$1.36051	$0.04968
Milling	.72232	.02638
General	.33475	.01222
	2.41758	.08828

Ore reserves of Miami Copper Co., Jan. 1, 1919.

	Quantity (short tons).	Percentage of copper.
High-grade sulphide ore	12,570,000	2.38
Low-grade sulphide ore	36,000,000	1.06
Mixed sulphide and oxide ore	6,000,000	2.00
	54,570,000	....

The production of refined copper by the Inspiration Consolidated Copper Co. for 1918 was 98,540,041 pounds. A total of 5,139,132 tons of ore was mined, of which 5,110,101 tons was concentrating ore and 29,031 tons oxidized ore. The oxidized ore was shipped direct to the smelter.

The average cost of copper exclusive of depreciation and Federal income tax was 11.259 cents a pound.

Mill statistics, Inspiration Consolidated Copper Co., 1918.

Total ore milled	dry tons	5,110,101
Ore milled per day	do	14,172
Average number of sections running		14.8
Average rate per section	tons	956
Screen analysis of feed (on 48 mesh)	per cent	3.4
Assay mill feed	per cent of copper	1.361
Copper in feed, oxidized	per cent	.291
Copper assay of general tailings	do	.380
Copper in general tailings, oxidized	do	.253
Copper in general concentrates, smelter assay	do	30.398
Copper in flotation concentrates	do	35.26
Copper in table concentrates	do	16.31
Moisture in general concentrates	do	20.46
Ratio of concentration		32.5
Recovery of copper calculated from (smelter assays):		
Assays only	per cent	72.99
Assays and weights of concentrates and ore	do	72.27
Assays and weights of concentrates and tails	do	72.82
Assays and weights of ore and tailings	do	73.02
Recovery of copper sulphides	do	88.51
Water used per ton of ore	gallons	310
Power used per ton of ore milled:		
Coarse crushing	kilowatt-hours	.45
Fine grinding and concentrating	do	10.12
Blowers for flotation air	do	2.79
Filtering and reclaiming water	do	2.32
Lighting	do	.12
Steel balls consumed per ton of ore milled	pounds	1.82
Flotation oil consumed per ton of ore milled:		
Coal tar	pounds	1.20
Other oils	do	.15

No new ore was developed during the year. The reserves December 31, 1917, were calculated as 87,864,378 tons.

The income for the year was $8,229,163.60. Dividends were paid to the amount of $9,455,736.

Morenci-Metcalf district.—The Morenci-Metcalf district is one of the oldest copper-producing districts in the State. Production began here in 1873 and since 1880 the district has been a large contributor to the copper output of the country. To the end of 1918 it has produced 1,422,063,000 pounds of copper, or 5.25 per cent of the output of the country since 1845. In total production it ranks fifth among the copper districts of the country. In the output for 1918 it ranks tenth.

Copper produced in Morenci-Metcalf district, 1906–1918.

Year.	Quantity.	Average yield of copper from ore.	Year.	Quantity.	Average yield of copper from ore.
	Pounds.	*Per cent.*		*Pounds.*	*Per cent.*
1906	56,000,000	....	1913	70,100,000	2.00
1907	63,000,000	....	1914	66,000,600	1.95
1908	77,000,000	....	1915	51,096,000	2.01
1909	72,000,000	2.29	1916	75,977,000	1.89
1910	73,154,000	2.35	1917	53,000,000	1.85
1911	71,500,000	2.29	1918	71,867,000	1.71
1912	79,900,000	2.21			

In 1918, of the mine production of copper, 54,204,000 pounds was derived from concentrating ores and 15,891,000 pounds from smelting ores. Some copper was also produced from slag and old tailings treated. The mines of the district produced 1,836,584 tons of concentrating ores and 216,369 tons of smelting ore.

The ores in general carry little gold and silver, and as much of the copper is of sufficient purity for commercial purposes it is not refined electrolytically, and consequently the precious-metal content is not separated from the copper.

Copper produced by Morenci branch of Phelps Dodge Corporation, 1911–1918.

Year.	Ore treated (short tons).	Copper produced.		Dividends.
		Quantity (pounds).	Percentage.	
1911	517,087	22,704,398	2.29	$800,000
1912	520,272	24,802,789	2.38	1,464,610
1913	537,324	22,255,130	2.07	780,000
1914	477,581	20,272,607	2.12	280,000
1915	376,604	15,333,976	2.03	....
1916	474,808	17,541,258	1.85	....
1917	333,263	13,202,201	1.98	....
1918	480,407	17,130,209	2.32	....

Copper produced by Morenci branch of Phelps Dodge Corporation, 1918, by kinds of ore.

	Ore treated.	Copper produced.	Assay of original ore.	Yield.
	Short tons.	*Pounds.*	*Per cent.*	*Per cent.*
Concentrating ore	448,884	12,174,053	1.91	1.356
Smelting ore	24,210	4,037,906	8.76	8.338
Old slag and tailings	1,444	93,575	3.42	3.240
Siliceous ore to converters	5,867	821,835	7.21	7.000
	480,405	17,127,369	2.32	1.783
Purchased scrap	2	2,840	75.00	75.000
	480,407	17,130,209	2.32	1.783

Result of concentration operations by Morenci branch of Phelps Dodge Corporation, 1918.

	Quantity (short tons).	Average assay (per cent of copper).
Ore concentrated	449,989.6	1.910
Concentrates produced	57,719.3	11.320
Tailings produced	....	.519

Saving	per cent..	76.22
Ratio of concentration		7.796
Proportion of actual running time to total time	per cent..	92.30

Result of smelting and converting operations of Morenci branch of Phelps Dodge Corporation, 1918.

Concentrates	short tons..	57,645.7	
Ore	do....	24,032.2	
Precipitates	do....	177.8	
			81,855.7
Secondaries:			
Converter slag and cleanings	do....	23,158.4	
Furnace cleanings	do....	671.2	
Flue dust	do....	25,113.1	
			48,942.7
Flux:			
Limestone	do		23,417.8
			154,216.2

Copper produced by Arizona Copper Co., 1911–1918.

Year ending Sept. 30.	Ore treated.	Copper produced.	Average yield.	Year ending Sept. 30.	Ore treated.	Copper produced.	Average yield.
	Short tons.	*Pounds.*	*Per cent.*		*Short tons.*	*Pounds.*	*Per cent.*
1911	744,746	34,584,000	2.32	1915	968,566	37,330,000	1.961
1912	927,116	38,132,000	2.057	1916	905,486	34,100,000	1.803
1913	936,903	34,226,000	1.938	1917	1,178,087	42,482,000	1.830
1914	1,079,950	38,756,000	1.808	1918	1,095,568	40,442,000	1.754

Metals produced by Shannon Copper Co., 1911–1917.

Year.	Ore treated.	Copper produced.	Average yield in copper.	Gold.	Silver.	Dividends.
	Short tons.	*Pounds.*	*Per cent.*	*Ounces.*	*Ounces.*	
Year ending August, 1911	263,975	15,168,102	2.845	1,690	91,955	....
Year ending August, 1912	285,210	16,406,336	2.876	2,615	170,690	$150,000
August to Dec. 31, 1912	95,235	5,149,805	2.704	1,012	54,394	....
1913	434,307	18,793,724	2.163	3,412	169,197	150,000
1914	193,297	9,003,169	2.33	1,295	60,603	....
1915	....	6,017,642	....	690	35,449	....
1916	....	9,364,968	....	1,327	62,935	150,000
1917	....	6,138,219	....	1,096	51,771	525,000

Jerome district.—The production of copper in the Jerome district began about 1883, though it had produced gold and silver prior to that time. Since 1888 it has been a steady and important producer. To the end of 1918 it has produced 1,135,120,000 pounds of copper, or 4.19 per cent of the total output of the country since 1845. In total output it stands seventh among the copper districts of the country and in output for 1918 it ranks sixth.

Copper produced in Jerome district, Ariz., 1906–1918.

Year	Pounds.	Year	Pounds.	Year	Pounds.
1906	38,500,000	1911	33,200,000	1915	53,260,000
1907	33,000,000	1912	31,680,000	1916	102,000,000
1908	36,000,000	1913	35,300,000	1917	145,900,000
1909	36,700,000	1914	30,000,000	1918	133,781,000
1910	38,600,000				

The United Verde Copper Co. was the largest producer in the district.

The United Verde Extension Mining Co. shipped and smelted 133,535 tons of ore containing 3,046 ounces of gold, 503,739 ounces of silver, and 55,491,077 pounds of copper.

The company's smelter was put into operation in July and subsequently all ores from the mine were treated at this plant.

Net earnings for the year amounted to $3,331,053.92. Dividends were paid to the amount of $1,575,000.

Ray or Mineral Creek district.—Notable production in the Ray or Mineral Creek district began in 1911, and the total production to the end of 1918 has been 474,804,000 pounds. Prior to 1918 the Ray Consolidated Mining Co. was the only important producer in the district.

Copper produced by Ray Consolidated Mining Co., 1911–1918.

Year.	Ore milled.	Copper content.	Mill recovery.	Refined copper.	Cost per pound.	Dividends.
	Short tons.	*Per cent.*	*Per cent.*	*Pounds.*	*Cents.*	
1911	681,519	1.83	63.1	14,935,047	10.75	....
1912	1,565,875	1.677	68.278	34,674,275	9.828	....
1913	2,365,296	1.719	66.09	52,341,029	9.783	$1,631,504
1914	2,427,700	1.76	67.88	57,004,281	8.839	1,089,323
1915	2,848,969	1.673	64.11	60,338,936	9.497	1,872,319
1916	3,332,340	1.607	70.20	74,983,540	10.267	4,337,955
1917	3,560,900	1.635	74.53	88,582,649	12.229	6,624,151
1918	3,411,000	1.613	74.92	83,599,160	17.695	5,125,831

Ore reserves at the end of the year were estimated at 86,383,642 tons, averaging 2.061 per cent copper. The concentrates are treated at the Hayden plant of the American Smelting & Refining Co.

Net income for the year amounted to $4,803,455.43.

Dividends were paid to the amount of $5,125,831.75.

The mill of the Ray Hercules Copper Co. was put in operation during the year. The developed ore is reported as 9,500,000 tons, averaging 1.77 per cent copper.

Ajo district.—The Ajo district is in Pima County, about 45 miles from Gila Bend, which is on the Southern Pacific Railroad and with which it is connected by the Tucson, Cornelia & Gila Bend Railroad.

During the year 1,859,161 tons of ore was mined by the New Cornelia Copper Co.; electrolytic copper was produced to the amount of 31,264,642 pounds; copper in cement copper, 10,990,666 pounds; and copper in ore shipped to smelters, 4,694,831 pounds, or a total ot 46,950,139 pounds.

It is estimated that at the end of 1918 there was fully developed by the New Cornelia Copper Co. 51,320,421 tons of ore of an average grade of about 1.57 per cent. Of this about 41,000,000 tons is sulphide ore. Steps were taken during the year for the construction of an experimental mill to determine a method for treatment of the sulphide ores.

Pioneer district.—The Pioneer district, Pinal County, produced 12,332,000 pounds of copper in 1918, as compared with 10,600,000 pounds in 1917.

The Magma Copper Co., of the Pioneer district, produced 10,968,556 pounds of copper in 1918, at an average cost of 16.425 cents a pound, the operating profits being $519,350.65.

Dividends were paid to the amount of $480,000.

Copper ore mined and treated and milling results of the Magma Copper Co., 1918.

	Ore.	Copper.	Silver.	Gold.
	Short tons.	*Per cent.*	*Ounces per ton.*	*Ounces per ton.*
Copper-sulphide ore	90,321	6.637	5.452	0.0591
Hand-sorted crude sulphide shipped direct to smelter	15,880	16.675	13.186	.1019
Mill heads	74,441	4.496	3.803	.05
Concentrates produced	29,588	10.782	9.413	.1379
Average assay of mill tailings	....	.3482	.430	Trace.

The mill recovery was 95.33 per cent of the total copper in the mill heads. The total copper recovery, including ore obtained by hand sorting, was 97.39 per cent of the copper contents of the mine-run ore.

The net production, after deducting all smelting and refining losses, was 10,968,556 pounds of copper, 463,503 ounces of silver, and 5,699 ounces of gold.

Copper shipments of Magma Copper Co. from beginning of operations to end of 1918.

	Ore.	Copper.	Silver.	Gold.
	Short tons.	*Per cent.*	*Ounces per ton.*	*Ounces per ton.*
Copper concentrates	100,606.3981	12.354	12.784	0.1289
Crude sulphides	52,476.5865	16.524	16.755	.0949
Crude carbonate	4,433.6240	8.014	5.266	.0550
	157,516.6086	13.621	13.895	.1155

The net production to date, after deducting all smelting and refining losses, has been 42,911,014 pounds of copper, 2,188,722.25 ounces of silver, and 18,196.103 ounces of gold.

Estimated ore reserves of Magma Copper Co. at end of 1918.

	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Ounces per ton.*	*Ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Reasonably assured copper sulphide ore	235,000	0.02	4.2	5.7	....	....
Reasonably assured lead-zinc ore	20,000	....	12.0	....	2.0	13.5

Silverbell district.—The Silverbell district, in Pima County, since 1904, when important production of copper in the district began, has yielded about 57,000,000 pounds of copper. The production in 1918 was 7,800,000 pounds. The Silver Bell mine, operated by the American Smelting & Refining Co., was the principal producer.

Other districts that made important production in 1918 are the Cochise district, and the Courtland (Turquoise) district, Cochise County, 4,174,000 pounds and 4,366,000 pounds, respectively; the Banner district, Gila County, 5,830,000 pounds; the Helvetia and Pima districts, Pima County, 2,156,000 pounds and 3,032,000 pounds, respectively; the Patagonia and Big Bug districts, Santa Cruz County, 4,028,600 and 7,936,000 pounds, respectively; and the Copper Basin, Peck, and Planet districts, Yuma County, 2,343,000, 2,214,000, and 1,743,000 pounds, respectively; Agua Fria district, Yavapai County, 2,495,000 pounds.

CALIFORNIA.

In 1918 California produced 44,150,761 pounds of blister copper, compared with 44,933,846 pounds in 1917.

California was among the earliest of the Western States to make a considerable output of copper. Production began in the foothill belt about 1862 and for several years California was second only to Michigan in output of copper. Later, however, the industry declined, and California did not again attain high rank as a copper producer until 1897, when production from the Shasta County district began. Since that time the State's output has been steady and large. To the end of 1918 California has produced about 744,907,444 pounds of copper, or 2.75 per cent of the output of the country since 1845. In 1918 the output was 2.31 per cent of the total production of the United States. In total output the State ranks sixth among the copper producers of the country and for 1918 it ranked eighth. Three smelting plants in the State treated copper ores in 1918.

Most of the copper has come from three districts, though numerous other districts have made production, especially in the last few years, and copper minerals are widely distributed over the State. The largest producer has been the Shasta County district.

Shasta County district.—The Shasta County copper belt lies in the Klamath Mountains, at the head of Sacramento Valley, a few miles north of Redding. Sacramento River crosses the belt, separating it into an eastern and a western portion. The eastern portion contains the Bully Hill and Afterthought districts and the western contains the Iron Mountain and Little Backbone districts. Placer mining was carried on in the county in the early days of mining in the State, and later considerable silver was produced from the gossan outcrop of the copper deposits. Copper minerals had been long known in the county, but not until 1897, when the Mountain Copper Co. (Ltd.) began production at Iron Mountain, did it become an important contributor of copper.

Copper produced in Shasta County district, Calif., 1906–1918.

Year.	Quantity (pounds).	Average yield of copper (per ct.).	Gold and silver. per ton.	Year.	Quantity (pounds).	Average yield of copper (per ct.).	Gold and silver per ton.
1906	21,000,000	3.6	$3.75	1913	26,800,000	3.50	$1.70
1907	28,000,000	3.0	2.70	1914	25,100,000	3.56	1.28
1908	32,000,000	3.2	2.85	1915	30,500,000	3.29	2.67
1909	48,000,000	3.4	2.02	1916	39,700,000	2.62	2.59
1910	36,000,000	3.0	2.14	1917	26,650,000	2.75	1.00
1911	29,900,000	3.7	1.80	1918	25,030,000	2.76	1.52
1912	26,000,000	3.58	1.84				

The total production to the end of 1918 has been about 565,679,000 pounds, or 2.09 per cent of the total output of the country. In 1918 the district produced 1.31 per cent of the total output. The district ranks ninth in total output and in the production for 1918 it ranks thirteenth among the copper districts of the country.

The principal producing companies in 1918 were the Mountain Copper Co., Mammoth Copper Co., and Balaklala Copper Co. The ores of the Mammoth Co. were smelted at its plant at Kennett, and the Mountain Co.'s ores were smelted at its plant at Martinez, on San Francisco Bay. The Balaklala ores were shipped to the Mammoth plant.

The Mammoth Copper Mining Co. produced 77,695 tons of copper ore.

The Friday Lowden ore body encountered in 1917 proved to be of considerable importance.

The Stowell mine was shut down after extracting the available ore. Development of the Keystone group of mines was in process.

The smelter treated 413,082 tons of charge, of which 236,142 tons were sulphide ore, including ore from the Balaklala and Trinity mines.

The mines of the Mountain Copper Co. were operated throughout the year.

There were shipments of ore from the Bully Hill and Afterthought districts.

Electric power is used almost exclusively at both mines and reduction plants.

The Shasta County belt is served by the Southern Pacific Railroad, which has short branches extending to the smelters. The Iron Mountain district is connected with the main line by a narrow-gage railroad operated by the Mountain Copper Co., and the mines of the Mammoth Co. are connected with the smelter by a combined electric railroad, gravity tram, and steam railroad. The ores of the Balaklala and Trinity mines are delivered to the railroad over a cable tramway. The Bully Hill district is served by a standard-gage branch of the Southern Pacific Railroad. The nearest railroad point to the Afterthought district is Bellavista, on the Anderson & Bellavista Railroad, at a distance of about 15 miles.

Foothill district.—The foothill belt is a rather extensive area of copper deposits which has its best development in Calaveras County. This belt furnished practically the entire copper production from California in the sixties. Subsequent to that period the district was inactive for many years, but from 1887 to 1892 the mines again made some production. The present period of activity began about 1901, and for some years the district has made considerable contributions to the copper output of the State.

There is no active record of the output of this district in the early days, but from the records of the production of the State it is estimated that to the end of 1918 it has yielded approximately 150,796,000 pounds of copper.

Copper produced in foothill district, Calif., 1907–1918.

Year.	Quantity.	Average yield.	Year.	Quantity.	Average yield.
	Pounds.	*Per cent.*		*Pounds.*	*Per cent.*
1907	4,500,000	5+	1913	5,800,000	4.5
1908	4,500,000	4	1914	4,400,000	5.0
1909	5,400,000	4.6	1915	3,700,000	5.44
1910	8,000,000	5.2	1916	6,460,000	3.07
1911	5,500,000	4.7	1917	8,000,000	4.15
1912	6,000,000	5.1	1918	6,937,000	2.07

In total output the district ranks thirteenth and in production for 1918 it ranked twenty-second among the copper districts of the country.

The Penn Mining Co. and the Calaveras Copper Co. were the largest producers.

Plumas County.—In 1918 Plumas County produced 11,192,000 pounds of copper. The principal producers were the Engels Copper Mining Co. and the Walker Mining Co.

Other counties.—San Bernardino County produced 1,351,000 pounds in 1918, and Placer and other counties made smaller production.

COLORADO.

In 1918 Colorado produced 7,591,570 pounds of blister copper, compared with 10,054,951 pounds in 1917. Although the State has no important producing district in which copper is the principal metal, yet it ranked tenth among the copper-producing States in 1918. The total recorded output for the State from the beginning of the industry is 274,837,414 pounds, or 1.01 per cent of the total for the United States since 1845.

The copper has been derived mainly from the treatment of mixed ores in which copper was a minor constituent, including lead-silver ores and pyritic ores rich in gold and silver. In 1918 the largest production came from Lake County and from San Juan, Ouray, San Miguel, Clear Creek, Chaffee, Dolores, Gilpin, and Fremont counties. Leadville and the San Juan-Ouray region have been the greatest producers of copper. Much of the output is recovered as matte in lead furnaces.

IDAHO.

During 1918 Idaho produced 5,836,795 pounds of blister copper, compared with 6,446,224 pounds in 1917. The State has made a small and irregular output of copper since 1884, but only since 1903 has it been a steady producer. To the end of 1918 it had a recorded output of 106,590,221 pounds.

Coeur d'Alene region.—The Coeur d'Alene region has been the most productive copper area in the State, though it is not the most productive at the present time. Complete figures for the copper output of the district are not on record, but the total production has been approximately 66,482,000 pounds. The Snowstorm mine has been the largest copper producer in the district.

Alder Creek district.—There has been intermittent production from the Alder Creek or Mackay district since 1900. In 1918 the mines of the district produced 3,504,000 pounds of copper. The largest producer was the Empire Copper Co.

Other districts.—There are other districts in Idaho, notably that of the Seven Devils region, which contain copper deposits, but owing to lack of transportation facilities they have made but small production.

MICHIGAN.

The production of refined copper in Michigan in 1918 was 231,096,158 pounds, compared with 268,508,091 pounds in 1917.

The mining of copper in Michigan antedates the earliest visits of European explorers to the region. The production on a commercial scale, however, dates from 1845, and since that time the State has been a steady producer and an important factor in the copper industry of the world. To the end of 1918 Michigan has produced 6,529,382,016 pounds of copper, or 24.09 per cent of the output from the United States since 1845. For many years subsequent to 1845 Michigan was the most important copper-producing State, and in total output it is second only to Montana and Arizona. The entire output comes from the Keweenaw or Lake Superior district.

Although the district has been an active producer for more than 70 years, many of the older mines still have large reserves of ore; new mines are being opened; and much territory remains to be prospected. Moreover, large quantities of the mill tailings produced when milling methods were less efficient than at present are being re-treated at a profit.

The Lake Superior region is unique in being the only district in the United States in which a large output is derived from native copper.

Copper ore produced in Lake Superior district, Mich., 1906–1918.

Year.	Quantity.	Yield of copper.	Year.	Quantity.	Yield of copper.
	Short tons.	*Per cent.*		*Short tons.*	*Per cent.*
1906	8,904,127	1.26	1913	7,016,370	0.97
1907	9,892,214	1.1	1914	9,269,413	.89
1908	10,531,271	1.06	1915	12,334,700	1.07
1909	11,429,394	1.02	1916	12,364,114	1.08
1910	10,869,561	1.02	1917	12,400,723	.99
1911	10,978,827	1.00	1918	11,321,365	.96
1912	11,411,941	.96			

The statistics in the following tables are compiled from the annual reports to the stockholders of the individual companies:

Ore milled and copper derived therefrom by Michigan companies in 1916, 1917, and 1918.

[Compiled from the annual reports of the producing companies.]

Company.	1916		1917		1918	
	Quantity.	Yield per ton.	Quantity.	Yield per ton.	Quantity.	Yield per ton.
	Short tons.	*Pounds.*	*Short tons.*	*Pounds.*	*Short tons.*	*Pounds.*
Ahmeek	1,164,010	20.7	1,271,275	22.0	1,196,541	20.8
Allouez	566,960	18.02	566,674	15.69	514,888	13.73
Baltic	369,287	33.65	325,342	34.47	293,601	34.44
Calumet & Hecla	3,166,274	22.53	3,159,570	21.65	2,876,392	20.42
Centennial	150,617	15.72	148,332	13.50	159,040	15.67
Champion	936,656	35.87	776,036	35.50	594,235	36.599
Franklin	267,286	....	303,625	....	273,964	....
Hancock	203,112	....	302,725	13.22	227,049	13.40
Houghton	19,444	10.55	15,628	11.45	....	....
Isle Royale	925,419	13.4	922,160	14.6	974,508	15.9
Keweenaw	6,915	9.96	41,148	9.248	....	....
La Salle	144,829	9.53	185,014	10.38	176,423	10.388
Mass	287,900	16.51	244,671	16.29	196,456	17.33
Michigan	....	....	2,091	....	40,865	28.81
Mohawk	664,547	20.82	605,202	20.35	454,293	23.73
New Arcadian	....	....	4,900	....	10,195	16.0
Osceola	1,284,681	15.2	1,237,805	13.0	1,194,967	13.3
Quincy	1,204,026	17.5	1,280,837	17.33	1,174,147	16.99
South Lake	....	....	[a] 68,388	11.03	7,694	28.09
Superior	185,315	16.38	129,587	16.99	106,213	15.78
Trimountain	349,504	24.94	264,655	23.72	201,433	26.52
Victoria	146,690	....	137,286	....	106,730	14.37
White Pine	188,890	22.27	212,889	19.11	194,568	16.83
Winona	161,828	13.39	112,082	13.33	57,837	14.157
Wolverine	388,898	17.07	352,845	16.60	303,498	15.185

[a] Includes from May, 1916, to Dec. 31, 1917.

Copper produced by Michigan mines in 1917 and 1918.

[Compiled from the annual reports of the producing companies.]

Company.	1917	1918			
	Quantity.	Quantity.	Cost per pound.	Price received per pound.	Profit per pound.
	Pounds.	*Pounds.*	*Cents.*	*Cents.*	*Cents.*
Ahmeek	27,919,812	24,851,235	14.30	24.30	10.00
Allouez	8,892,915	7,071,218	19.73	24.49	4.76
Baltic	11,214,861	10,406,097	15.07	24.757	9.687
Calumet & Hecla	68,419,826	[a] 67,968,357	21.05	24.28	3.23
Centennial	2,002,857	2,492,857	18.65	24.61	5.96
Champion	27,550,343	21,748,514	11.92	24.757	12.837
Franklin	3,155,574	2,827,313	....	24.349	....
Hancock	4,047,053	3,041,514	....	24.2992	....
Houghton	179,012	....	....	....	....
Isle Royale	13,480,921	15,442,508	16.51	24.46	7.95
Keweenaw	380,536	....	....	....	....
La Salle	1,919,775	1,832,665	21.81	24.35	2.54
Mass	3,984,616	3,403,827	23.82	24.34	.52
Michigan	35,400	1,177,176	....	24.7	....
Mohawk	12,313,887	10,781,041	14.641	24.73	10.089
New Arcadian	53,278	164,794	....	....	....
Osceola	16,084,958	15,919,647	17.67	24.41	6.74
Quincy	22,195,577	19,948,965	....	24	....
South Lake	754,433	226,141	....	....	....
Superior	2,201,672	1,676,446	25.06	24.22	....
Trimountain	6,278,097	5,343,586	18.42	24.757	6.337
Victoria	1,612,640	1,533,536	....	....	....
White Pine	4,067,529	3,273,680	24.27	24.30	.03
Winona	1,494,472	[b] 1,576,683	....	26.0	....
Wolverine	5,856,889	4,608,865	18.927	24.2	5.273
	....	....	17.835	24.405	6.57

[a] Includes 9,245,388 pounds reclaimed from tailings.
[b] Includes 756,826 pounds produced by lessee.

The district is well located for cheap working of the mines. The Great Lakes furnish cheap transportation for both coal and copper, and the Lake steamers reach the heart of the district by Portage Lake and the Houghton Ship Canal. The district is served by the Mineral Range, Copper Range, and Keweenaw Central railroads and is connected with the main lines of traffic by the Chicago, Milwaukee & St. Paul and Duluth. South Shore & Atlantic railways.

MONTANA.

The output of blister copper from Montana in 1918 was 326,426,761 pounds, compared with 276,225,977 pounds in 1917.

The first record of production of copper from Montana was in 1868, but the State did not become a large contributor of this metal until 1880. Since that time the increase in its output of copper has been steady and rapid. To the end of 1918 the State has produced 7,657,889,645 pounds, or 28.25 per cent of the total output of the United States since 1845. In total production the State ranks first, and in the output for 1918 it ranked second. The Butte district has furnished nearly the entire output.

Three copper-smelting plants were operated in Montana in 1918—that of the East Butte Mining Co., at Butte, and those of the Anaconda Copper Mining Co., at Anaconda and at Great Falls.

Butte district.—To the end of 1918 Butte has produced about 7,621,600,000 pounds of copper, or 28.12 per cent of the total output of the country since 1845. Both in total production and in the output in 1918 it ranks first among the copper-producing districts of the United States.

Copper and associated metals produced in Butte district, Mont., 1906–1918.

Year.	Copper.	Average yield in copper.	Gold.	Silver.	Year.	Copper.	Average yield in copper.	Gold.	Silver.
	Pounds.	*Per cent.*	*Ounces per ton.*	*Ounces per ton.*		*Pounds.*	*Per cent.*	*Ounces per ton.*	*Ounces per ton.*
1906	294,000,000	3.15	0.01	2.0	1913	283,600,000	2.70	0.0058	1.92
1907	222,000,000	2.75	.014	2.3	1914	235,700,000	2.66	.0059	1.83
1908	252,500,000	3.3	.0075	2.16	1915	267,000,000	2.66	.0066	1.82
1909	314,000,000	3.08	.0076	2.07	1916	349,500,000	2.81	.0059	1.79
1910	282,500,000	3.13	.0068	2.02	1917	270,500,000	2.81	.0056	1.84
1911	271,200,000	3.17	.0071	2.20	1918	321,104,000	2.17	.0059	2.03
1912	308,000,000	3.02	.0065	2.09					

Copper, gold, and silver produced by Anaconda Copper Mining Co. from company ores, 1913–1918.

Year.	Ore treated.	Copper.	Silver.	Gold.	Dividends.
	Short tons.	*Pounds.*	*Ounces.*	*Ounces.*	
1913	4,566,451	241,983,323	8,719,132	64,898	$12,997,500
1914	3,768,640	205,298,531	7,221,815	99,651	9,077,500
1915	4,258,129	235,076,289	8,064,986	106,702	9,325,000
1916	5,273,066	307,395,092	10,790,705	92,099	17,484,375
1917	3,906,901	239,014,880	8,368,180	58,545	19,815,625
1918	4,350,446	272,923,031	10,076,748	64,318	....

The annual report of the company states that

The mines of the company produced during the year 4,918,468.30 tons of ore and 6,553.69 tons of precipitates, a total of 4,925,021.99 tons.

The copper reduction works treated for all companies during the year 4,959,580 tons of ore and other cupriferous material at Anaconda and 57,000 tons of ore and other cupriferous material at Great Falls. Of this amount 4,350,446 tons of ore were produced by company mines, 618,256 tons of ore were either purchased from or treated for other companies, and 47,878 tons of precipitates and cleanings from the old works at Anaconda and Butte were treated.

At Anaconda there were produced 279,030,318 pounds of fine copper, 10,001,604.81 ounces of silver, and 59,403.116 ounces of gold.

At Great Falls there were produced 14,573,408 pounds of fine copper, 966,300.31 ounces of silver, and 4,914.506 ounces of gold.

Or a total production at both Anaconda and Great Falls of 293,603,726 pounds of fine copper, 10,967,905.12 ounces of silver, and 64,317,622 ounces of gold.

Of the total production at these plants 272,923,031 pounds of fine copper, 10,076,747.98 ounces of silver, and 64,317.622 ounces of gold were produced for your company.

The electrolytic copper refinery at Great Falls produced during the year 191,404,125 pounds of cathodes, 189,067,167 pounds of which were melted into shapes at Great Falls.

The copper leaching plant at Anaconda treated during the year 500,688 tons of tailings and 64,978 tons of copper ore, from which there were produced 6,662 tons of cement copper.

Copper, silver, and gold produced by North Butte Mining Co., 1912–1918.

Year.	Copper ore and precipitates treated.	Copper.	Silver.	Gold.	Dividends.
	Short tons.	*Pounds.*	*Ounces.*	*Ounces.*	
1912	425,297	26,480,123	1,377,468	1,367	$697,000
1913	455,029	28,318,321	1,602,163	1,567	820,000
1914	337,415	18,421,761	1,092,300	1,107	635,000
1915	378,161	19,235,285	940,631	1,121	387,000
1916	544,456	24,498,181	1,047,063	1,712	1,075,000
1917	296,773	14,493,452	662,845	959	1,075,000
1918	453,356	20,680,695	891,157	1,375	430,000

The average cost of producing copper for the year 1918 was 20.917 cents a pound.

Copper produced by East Butte Copper Mining Co., 1912–1918.

Year.	Ore mined.	Average copper content.	Copper produced by smelter.	Average cost per pound of copper.
	Short tons.	*Per cent.*	*Pounds.*	*Cents.*
1912	99,458	5.78	14,709,460	9.698
1913	105,071	5.16	14,401,108	11.040
1914	72,853	4.72	9,175,578	11.110
1915	150,911	4.28	12,542,058	11.853
1916	258,899	3.67	18,340,713	16.887
1917	189,473	4.31	20,013,900	17.672
1918	184,493	4.25	24,599,890	19.712

The company reports that ore developed during the year equaled that extracted.

Operations of East Butte Copper Mining Co. for 1918.

Ore mined (wet weight) short tons		184,493
Average assay value per cent		4.25
Cost of mining per ton, including development		$9.02
Company ore treated (dry weight) short tons		178,948
Custom ore treated (dry weight) do		83,038
Total ore treated do		261,986
Copper produced pounds		24,599,890
Silver produced ounces		776,818
Gold produced do		1,419
Gross value of metals shipped		$5,771,187.15
Other income		104,135.38
Gross income from operations		5,875,322.53
Cost of mining, treatment, freight, selling, refining, and cost of custom ore purchased	$4,963,844.51	
Miscellaneous operations	69,333.45	
		5,033,177.96
		842,144.57
Less depreciation	5,921.99	
Ore depletion	17,014.50	
		22,936.49
		819,208.08
Less exploration and development		53,738.97
Net surplus on operations		765,469.11
Copper produced pounds		24,599,890
Price per pound received, New York cents		22.1387
Cost of production per pound do		19.7117
Profit per pound do		2.4270
Average price per ounce received for silver, New York cents		99.9792
Price per ounce received for gold, New York		$20.00

During the year the Tuolumne Copper Mining Co. took over the Butte Main Range Copper Co. and the Colusa Leonard Extension Copper Co. The main production for the year was from the Main Range mine, which produced 23,534 dry tons of ore, averaging 2.253 per cent of copper, and 8.082 ounces of silver and 0.0075 ounce of gold per ton.

For the fiscal year ending June 30, 1918, the Davis-Daly Copper Co. made the following production:

Production of Davis-Daly Copper Co. for the fiscal year ending June 30, 1918.

Shaft.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Tons.	*Ounces.*	*Ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Colorado	52,996		260,672	5,894,396		
Hibernia	5,724	356	129,816		611,907	1,316,310

NEVADA.

The production of blister copper in Nevada in 1918 was 106,266,603 pounds, compared with 115,028,161 pounds in 1917.

The earliest record of the production of copper in Nevada was in 1873, but the State did not become an important factor in the copper industry until 1908, when production from the Ely district began. To the end of 1918 Nevada has a recorded production of 822,115,262 pounds, or 3.03 per cent of the output of the country since 1845. In total production and in the output for 1918 Nevada ranks fifth among the copper-producing States.

A large part of the output has come from two districts—the Ely district, in White Pine County, and the Yerington district, in Lyon County.

Ely (Robinson) district.—The Ely district, White Pine County, had the largest production of copper in Nevada in 1918. Although it had long been known that the district contained copper deposits, production did not begin until 1908, when the Steptoe Valley smelting and concentrating plant was completed.

To the end of 1918 the output has been about 720,164,000 pounds. The district has yielded 2.66 per cent of the total output of the country since 1845, and it has produced 4.84 per cent of the output in 1918. In total production it ranks eighth and in the production for 1918 it ranked seventh among the copper districts of the country.

Smelter production of metals in Ely (Robinson) district, Nev., 1908–1918.

Year.	Ore.	Copper produced.	Average yield in copper.	Gold and silver per ton of ore.
	Short tons.	*Pounds.*	*Per cent.*	*Cents.*
1908	429,925	14,776,363	1.72	24
1909	1,671,225	51,700,000	1.72	24
1910	2,346,354	62,332,419	1.30	21
1911	2,745,524	65,262,796	1.19	17
1912	2,985,217	64,932,446	1.09	17
1913	3,419,178	69,950,850	1.02	13.4
1914	2,749,913	51,089,921	.93	16
1915	3,204,374	64,638,158	1.01	19
1916	4,053,526	93,037,587	1.14	20
1917	4,466,017	93,615,335	1.05	18
1918	4,519,445	92,396,638	1.02	24

Metals produced by Nevada Consolidated Copper Co., 1909–1918.

Year.	Ore treated.	Average assay of copper.	Average extraction of copper.	Gold and silver recovered per ton.	Refined copper produced.	Average cost of copper per pound.	Dividends.
	Short tons.	*Per cent.*	*Per cent.*	*Cents.*	*Pounds.*	*Cents.*	
1909	1,065,385	2.34	70.73	23.12	34,527,823	7.14	....
1910	2,237,028	2.06	69.59	21.14	60,513,009	7.37	$2,982,644
1911	3,338,242	1.80	67.59	17.35	78,541,270	7.17	3,746,895
1912	2,852,515	1.692	68.25	16.48	63,063,261	8.86	2,999,137
1913	3,139,137	1.599	68.52	12.32	64,972,829	9.99	2,999,185
1914	2,640,294	1.483	68.48	13.45	49,244,056	10.16	2,249,389
1915	3,081,520	1.54	70.18	18.56	62,726,651	8.67	2,999,185
1916	3,922,634	1.632	73.87	20.44	90,735,287	10.17	7,497,963
1917	4,064,095	1.462	73.08	....	82,040,508	12.45	8,297,746
1918	3,999,526	1.506	69.95	....	76,607,062	17.98	6,498,235

Ore reserves of the Nevada Consolidated Copper Co., Dec. 31, 1918.

	Ruth.		Copper Flat.		Total.	
	Quantity (short tons).	Per cent of copper.	Quantity (short tons).	Per cent of copper.	Quantity (short tons).	Per cent of copper.
Total ore developed to Dec. 31, 1917	15,570,600	2.24	80,295,777	1.47	95,866,377	1.60
Add during year 1918 from development and recalculation	119,168		2,404,680	1.36	2,523,848	1.28
	15,689,768	2.22	82,700,457	1.468	98,390,225	1.58
Total ore milled to Dec. 31, 1918	2,984,724	1.98	26,855,857	1.579	29,840,581	1.619
Recoverable ore remaining Dec. 31, 1918	12,705,044	2.24	55,844,600	1.414	68,549,644	1.57

There was at the end of the fiscal year a total of 165,239 tons of siliceous carbonate ore, averaging 2.5 per cent of copper, mined and stored in stock piles in addition to the sulphides given in the above table.

In addition, as reported at the end of 1917, there is developed in the Kimberly mine 664,439 tons of ore, averaging 2.02 per cent of copper; in the Wedge, 43,960 tons, averaging 3.12 per cent of copper; and in the Veteran, 155,800 tons, averaging 3.89 per cent of copper. Net profits for the year amounted to $3,252,070.53.

The production of the Consolidated Coppermines Co. for 1918 is shown in the following table:

Ore mined, grade of ore, and metal produced by the Consolidated Coppermines Co. in 1918.

Mine.	Ore, dry weight.	Copper produced.	Gold produced.	Silver produced.	Lead produced.	Zinc produced.	Manganese produced.
	Short tons.	*Pounds.*	*Ounces.*	*Ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Morris-Brooks	246,417	4,528,774	2,589.489	5,504.89			
Alpha	53,518	7,407,022	25.202	662.03			
Ora	193,749	3,621,813	1,649.720	4,237.21			
Leases	3,109	210,872	73.444	7,010.65	178,451	768,101	323,170
	496,793	15,768,481	4,337.855	17,414.78	178,451	768,101	323,170

Concentrating results at Steptoe mill of Nevada Consolidated Copper Co. on Consolidated Coppermines Co.'s ores treated.

Ore milled	short tons	201,198
Concentrates produced	do	20,159
Ratio of concentration, 10.02 into 1.		
Grade of ore	per cent of copper	1.52
Grade of concentrates	do	9.84
Recovery	per cent	64.00

Ore reserves of the Consolidated Coppermines Co. at the close of 1918.

	Quantity (short tons).	Per cent of copper.
Fully developed disseminated sulphide porphyry ore	9,957,700	1.41
Partly developed disseminated sulphide porphyry ore	9,695,000	1.25
	19,653,034	1.33
Heavy sulphide ore	156,000	3.21
Alpha oxidized ore	100,000	8.00

Yerington district.—The Yerington or Mason district is in Lyon County, 50 miles southeast of Reno. It includes the productive portion of the Singatse Range, a low desert range lying between Mason Valley on the east and Smith Valley on the west.

The district did not begin to produce on a large scale prior to 1912.

Copper produced in Yerington district, Nev., 1912–1918.

	Pounds.		Pounds.
1912	14,700,000	1916	3,491,000
1913	14,400,000	1917	19,396,000
1914	7,480,000	1918	17,139,000
1915	700,000		

The smelter of the Mason Valley Mines Co. was operated throughout the year, smelting 336,943 tons of ore and 11,689 tons of metal-bearing fluxes, of which 117,251 tons of ore were from company property, 788 from properties held under option, and 218,904 from outside sources, from which there was produced 809 ounces of gold, 91,824 ounces of silver, and 15,475,851 pounds of copper.

Net profits for the year were $178,202.47.

The Bluestone Mining & Smelting Co. and the Nevada-Douglas Consolidated Copper Co. made important production during the year.

Other districts.—Copper was produced in the Santa Fe district, Mineral County; Railroad and Contact districts, Elko County; Jack Rabbit district, Lincoln County; Battle Mountain district, Humboldt County; Yellow Pine district; and there were smaller outputs in many other districts.

NEW MEXICO.

The production of blister copper from New Mexico in 1918 was 96,559,580 pounds, compared with 107,593,615 pounds in 1917.

Production of copper from New Mexico began in the last years of the eighteenth century, native copper from the mines of Grant County being carried to Mexico City and coined into money. During the nineteenth century, however, there was but small output. A little copper was reported for the year 1858, but New Mexico did not have a steady output until after 1880, and did not become a large producer until 1912.

From 1845 to 1918 New Mexico had a recorded output of 585,589,415 pounds of copper, or 2.16 per cent of the total output of the country. The principal producing districts are those of Grant County.

Santa Rita district.—The Santa Rita district was probably the first district in the West in which there was any notable production of copper; the output began in the closing years of the eighteenth century, and the metal went to Mexico for coinage. There are no accurate records of the production for this early period of operation.

From the best sources available it is estimated that the total production of copper to the end of 1918 has been 532,886,000 pounds.

Copper produced in Santa Rita district, N. Mex., 1906–1918.

	Pounds.		Pounds.		Pounds.
1906	3,075,000	1911	1,400,000	1916	74,228,000
1907	5,000,000	1912	25,000,000	1917	82,200,000
1908	4,000,000	1913	50,511,000	1918	77,547,000
1909	3,000,000	1914	54,000,000		
1910	2,670,000	1915	65,000,000		

The Chino Copper Co. began producing late in 1911.

Metals produced by Chino Copper Co., 1911–1918.

Year.	Ore milled.	Copper content.	Mill recovery.	Production of refined copper.	Gold and silver per ton.	Cost of copper per pound.	Dividends.
	Short tons.	*Per cent.*	*Per cent.*	*Pounds.*	*Cents.*	*Cents.*	
1911				986,375			
1912	1,120,375	2.077	61.63	27,776,088		7.69	
1913	1,942,700	2.033	67.31	50,511,661		8.78	$1,919,070
1914	1,907,300	2.115	67.858	53,999,928	2.71	7.60	2,169,065
1915	2,379,800	2.155	66.588	64,887,788	3.35	7.12	2,609,860
1916	3,094,400	1.83	66.59	72,319,508	2.60	8.70	7,177,335
1917	3,608,100	1.64	69.32	79,636,235	1.59	11.39	8,612,802
1918	3,836,400	1.63	63.275	75,655,641	1.09	17.178	[a] 3,914,910

[a] $1,087,475 represents distribution of capital.

Section No. 6 of the mill and part of No. 7 were put into operation during the year. The treatment of oxidized ores was not begun. Ore reserves at the close of the year were estimated at 96,552,026 tons, averaging 1.63 per cent of copper.

Burro Mountain district.—The Burro Mountain district, southwest of Silver City, produced about 17,100,000 pounds of copper in 1918. The total production from the district has probably been about 51,466,000 pounds.

The gross production from the mines of the Burro Mountain Copper Co. was 17,293,266 pounds of copper and 43,150 ounces of silver.

Metals produced by Burro Mountain Copper Co., 1918.

	Quantity (dry weight).	Per cent of copper.	Copper produced.	Silver produced.
	Short tons.		*Pounds.*	*Ounces.*
Concentrates	53,146.000	14.875	15,178,760	43,149.66
Precipitates	8.165	62.890	9,859	
	53,154.165		15,188,619	43,149.66
Lease ore	24,824.054	4.239	2,104,647	
	77,978.219		17,293,266	43,149.66

Operations of the concentrator of the Burro Mountain Copper Co., 1918.

Ore milled	short tons	585,083
Average assay	per cent of copper	1.928
Moisture of general heads	per cent	3.094
Copper in ore milled	short tons	11,283.295
Concentrates produced	do	53,146
Average assay	per cent of copper	14.875
Tailings produced	short tons	531,937
Average assay	per cent of copper	.630
Saving (average of four methods of figuring)	per cent	70.232
Yield	do	1.351
Ratio of concentration		11.009
Ore milled per day, actual running time	short tons	1,709.519
Water used per ton of ore milled	gallons	736.514
Kilowatt hours per ton of ore milled		10.159

From the leaching beds at the mine 8.9 per cent of the total copper in the heaps was recovered, making a recovery of 33.8 per cent in a period of two years.

Lordsburg district.—The Lordsburg district, in central Grant County, has been a steady producer of copper for several years.

The Eighty Five Mining Co. was the largest producer.

Copper produced in Lordsburg district, N. Mex., 1906–1918.

[Mine figures.]

	Pounds.		Pounds.		Pounds.
1906	213,000	1911	2,455,000	1916	4,755,000
1907	463,000	1912	3,156,000	1917	4,262,000
1908	259,000	1913	1,601,000	1918	2,215,000
1909	590,000	1914	2,615,000		
1910	1,628,000	1915	3,890,000		

TENNESSEE.

The production of blister copper in Tennessee in 1918 was 15,053,568 pounds, compared with 16,093,757 pounds in 1917.

The entire output came from the Ducktown district, in the extreme southeastern part of the State, in Polk County. The district was one of the earliest large producers in the country. Operations began about 1850, and from that date till the end of the Civil War there was a large production from the "black copper" ores. With the exhaustion of the rich secondary deposits attempts were made to work the lean original sulphides. These efforts met with only indifferent success, and in the late seventies the smelters were shut down, thus ending the first period of activity in this district. The present period of activity began in 1890, when the Ducktown Sulphur, Copper & Iron Co. began operations. Since that time the district has been a steady producer from the primary sulphide ores. To the end of 1918 the total output of the district has been 351,112,000 pounds.

Metals produced in Ducktown district, Tenn., 1906–1918.

[Smelter figures.]

Year.	Ore treated.	Copper produced.	Average yield of copper.	Gold and silver per ton of ore.
	Short tons.	*Pounds.*	*Per cent.*	*Cents.*
1906	538,141	17,809,442	1.7	8
1907	558,487	19,475,119	1.77	7
1908	618,806	19,710,103	1.55	5
1909	576,680	19,207,747	1.66	6
1910	552,796	16,691,777	1.52	8
1911	581,974	18,965,143	1.62	11.7
1912	603,229	18,395,256	1.53	10.5
1913	652,253	19,489,654	1.476	11.2
1914	653,621	18,661,112	1.435	9
1915	623,534	18,205,308	1.45	9
1916	482,495	14,556,278	1.52	14
1917	589,004	16,093,757	1.37	15
1918	529,012	15,053,568	1.42	18

A part of the copper has been marketed without refining and without recovering the gold and silver contained. This accounts in large part for the variation in the gold and silver recovered per ton of ore treated.

The fact that the ores can be extracted with little timbering, the cheap supply of coke and coal from Tennessee and West Virginia, and the comparatively low cost of labor have made it possible to mine and treat these low-grade ores at a profit.

The pyritic process of smelting is practiced successfully by both the Ducktown Sulphur, Copper & Iron Co. and the Tennessee Copper & Chemical Corporation. The low-grade matte produced by the first smelting is resmelted and brought to a proper grade for conversion.

Sulphuric acid plants are operated by both companies. The successful operation of these plants has not only helped to solve the troublesome smelter-smoke problem but has added very materially to the revenue of the companies.

The companies of the district are limited in their output of copper by the fact that some sulphur fumes necessarily escape into the air, and the volume that may be permitted to escape is limited by order of the courts.

Copper and sulphuric acid produced by Tennessee Copper & Chemical Corporation, 1911–1918.

Year.	Ore smelted.	Copper.	Sulphuric acid 60° Baumé.	Cost of copper per pound.	Dividends.
	Short tons.	*Pounds.*	*Short tons.*	*Cents.*	
1911	436,285	13,808,940	....	10.88	$300,000
1912	444,289	13,252,634	192,084	11.00	500,000
1913	470,135	13,493,140	197,712	11.34	750,000
1914	485,051	12,871,113	210,163	11.84	600,000
1915	475,301	12,750,418	210,666	10.53	600,000
1916	385,188	9,404,295	181,637	14.36	150,000
1917	457,902	10,547,708	262,857	14.90	....
1918	402,071	9,819,838	283,092	18.526	392,817

The company's reserves of ore in the Burra Burra, London, and Polk County mines at the end of 1918 were estimated at 3,480,911 tons.

In July, 1919, the Ducktown Sulphur, Copper & Iron Co. reported developed ore reserves in the Mary mine as 1,500,000 tons and low-grade ore in the Isabella mine as 2,500,000 tons and in the Cherokee mine as 1,000,000 tons.

A process is being worked out for the treatment of the company's low-grade ore which it is expected will result in doubling the output of copper.

The district is served by a branch line of the Louisville & Nashville Railroad, with which the mines and smelters of the companies are connected by private line.

UTAH.

In 1918 Utah produced 230,964,908 pounds of blister copper, compared with 227,840,447 pounds in 1917.

The first recorded production of copper from Utah was in 1870, but the State did not become a large copper producer until about 1900. Since that time the growth of the industry has been steady and rapid. The total recorded output from the State to the end of 1918 is 2,108,536,950 pounds, or 7.78 per cent of the output of the United States since 1845. In 1918 Utah produced 12.10 per cent of the output. In total output and in the production for 1918 it ranks fourth among the copper-producing States.

Two copper-smelting plants were operated in the State during 1918, the Garfield smelter, at Garfield, and the International smelter, at Tooele.

Bingham district.—The presence of copper minerals in the Bingham district has been known since the early days of mining in the district, but for many years operations were confined to the production of lead, silver, and gold, and not until 1896 did the mining of copper ore become of commercial importance. To the end of 1918 the district has produced approximately 1,809,713,000 pounds of blister copper, or 6.68 per cent of the output of the country since 1845. For 1918 the district yielded 211,195,000 pounds of copper, or 11.06 per cent of the total production. In total output the district ranks fourth among those of the country and in the production for 1918 it ranks third.

Copper produced (mines report) in Bingham district, Utah, 1906–1918.

	Pounds.		Pounds.		Pounds.
1906	39,424,000	1911	129,996,000	1916	223,620,000
1907	45,432,000	1912	116,622,000	1917	225,412,000
1908	71,156,000	1913	144,920,000	1918	211,195,000
1909	92,560,000	1914	141,925,000		
1910	113,726,000	1915	176,593,000		

The concentrating ore of the district is treated at the mills at Garfield and Lark. The ores and concentrates are smelted at the Garfield and International smelters.

Metals produced by Utah Copper Co., 1911–1918.

Year.	Ore milled.	Copper content.	Mill recovery.	Refined copper.	Gold and silver per pound of copper.	Cost per pound of copper.	Dividends.
	Short tons.	*Per cent.*	*Per cent.*	*Pounds.*	*Cents.*	*Cents.*	
1911	4,680,801	1.51	69.53	93,514,419	1.07	7.865	$4,703,022
1912	5,315,321	1.36	66.32	91,366,337	.95	9.024	4,729,747
1913	7,519,392	1.25	63.95	113,942,834	.64	9.498	4,747,710
1914	6,470,166	1.42	66.04	115,690,445	.75	8.131	4,827,885
1915	8,494,300	1.43	64.13	148,397,006	.62	6.61	6,904,082
1916	10,994,000	1.43	62.34	187,531,824	.65	6.95	19,493,880
1917	12,542,000	1.337	61.10	195,837,111	.70	10.95	23,555,105
1918	12,160,700	1.226	65.11	188,092,405	.79	....	[a] 16,244,900

[a] Includes $3,655,102.50 capital distribution.

Costs of mining, milling, and concentrating copper ore by Utah Copper Co., 1910–1918.

Year.	Ore.	Cost per ton.			
		Mining.	Transportation.	Milling.	Total.
	Short tons.				
1910	4,340,245	$0.4097	$0.2978	$0.4663	$1.1738
1911	4,680,801	.4479	.3078	.4168	1.1725
1912	5,315,321	.4233	.2848	.4158	1.1239
1913	7,519,392	.3288	.2797	.3676	.9761
1914	6,470,166	.3232	.2782	.3536	.9550
1915	8,494,300	.2441	.2781	.3402	.8624
1916	10,994,000	.2781	.2792	.3782	.9355
1917	12,542,000	.4446	.2794	.6930	1.4170
1918	12,160,700	.5370	.2983	.9277	1.7630

The leaching plant was operated during the year with the following results:

A total of 434,143 tons of oxidized ore, or an average of 1,190 tons per diem, was treated. The ore averaged 0.822 per cent of copper, of which 0.665 per cent, or 13.30 pounds to the ton, was in soluble form. The recovery in leaching was 11.10 pounds to the ton, corresponding to an extraction of 83.31 per cent of the soluble copper. The recovery of the metal from the solution, in the form of a precipitate, was 0.5297 per cent, or 10.594 pounds of copper to the ton. The precipitate averaged 48.7727 per cent of copper, 9.6066 per cent of iron, and 2.74 per cent insoluble. The consumption of 60° Baumé sulphuric acid averaged 55.7 pounds to the ton, corresponding to 5 pounds of acid to the pound of copper recovered in leaching.

Revised calculations show that at the end of the year there was developed in the property 453,421,400 tons of ore, averaging 1.375 per cent of copper, of which 270,000,000 tons is classed as fully developed and 183,421,400 tons as partly developed. There was mined from the entire property prior to January 1, 1919, a total of 79,381,400 tons of ore, averaging 1.397 per cent of copper, and the reserves therefore amount to 374,040,000 tons, averaging 1.370 per cent of copper. The year's addition to reserves was 2,288,000 tons in excess of the quantity mined during that period.

At the end of the year 1918 an ore area of 226.3 acres had been outlined by underground workings and churn drilling. No attempt was made to add to this area, but some drilling was done in order to obtain data for future steam-shovel operations. The churn drilling, however, increased the calculated average thickness of developed and partly developed ore from 538 to 556 feet.

The net operating income for the year amounted to $13,807,302.65.

Copper, gold, and silver produced by Utah Consolidated Mining Co., 1911–1918.

Year.	Ore.	Copper content.	Gold per ton.	Silver per ton.	Copper.[a]	Dividends.
	Short tons.	*Per cent.*	*Ounces.*	*Ounces.*	*Pounds.*	
1911	162,522	2.891	0.0936	0.9815	9,162,023	$150,000
1912	159,143	2.146	.077	.828	6,506,814	450,000
1913	181,077	1.987	.056	.705	7,710,668	450,000
1914	153,345	2.509	.085	.996	7,584,391	600,000
1915	207,119	2.22	.075	1.02	8,836,091	600,000
1916	360,034	1.734	.052	.796	12,211,118	1,125,000
1917	226,536	1.797	.050	.764	7,968,165	1,050,000
1918	221,651	2.03	.054	.82	8,476,197	450,000

[a] Includes copper derived from lead ores.

In recent years the Utah Consolidated Co. has been a large producer of lead ores, the yield in 1918 being 7,812,653 pounds. At the end of the year there was "in sight" in the mine 277,939 tons of copper ore, carrying 2.33 per cent of copper and averaging 0.048 ounce of gold and 0.78 ounce of silver per ton. The ore was shipped by aerial train to the International smelter.

The Utah Consolidated Mining Co. during the year purchased the Yampa mine from the Tintic Mining & Development Co.

The mines and mill of the Ohio Copper Co. were operated throughout the year.

Several other mines in the district yielded considerable quantities of copper and copper-lead ores, notably the Old Jordan mine of the United States Mining Co., the Yampa mine, the Bingham-New Haven mine, and the Utah Apex mine.

The district is served by a branch of the Denver & Rio Grande Railroad and by the Bingham & Garfield Railway, controlled by Utah Copper Co. interests, which connects the mines at Bingham with the mills at Garfield. Cable tramways are employed to a considerable extent; the ores from the Utah Consolidated mines are delivered to the International smelter in this manner, and ores from other mines are delivered to the railroad over cable tramways.

Tintic district.—The production of copper from the Tintic district is largely incidental to the production of other metals. The quantity of ore in which copper is the most valuable metal constituent is small. There has been a small output of copper from the district for many years, but no accurate statistics of the early output are available. It is estimated that to the end of 1918 the district has yielded 146,525,000 pounds of blister copper.

Copper produced (mines report) in Tintic district, Utah, 1906–1918.

	Pounds.		Pounds.		Pounds.
1906	7,322,000	1911	10,922,000	1916	7,107,000
1907	7,756,000	1912	13,339,000	1917	9,118,000
1908	5,708,000	1913	9,262,000	1918	6,569,000
1909	5,916,000	1914	5,290,000		
1910	8,994,000	1915	5,358,000		

Beaver County.—The first notable production of copper from Beaver County came from the Horn Silver mine in 1889, and since that time copper has been produced from lead-silver ores and from small copper mines. The importance of the district as a copper camp dates from the starting of the mill in 1905 to treat ores of the Cactus mine. To the end of 1918 the district has yielded about 48,537,000 pounds of copper.

Copper produced (mines report) in Beaver County, Utah, 1906–1918.

	Pounds.		Pounds.		Pounds.
1906	5,406,000	1911	3,739,000	1916	3,204,000
1907	5,640,000	1912	3,040,000	1917	3,702,000
1908	5,706,000	1913	3,137,000	1918	2,636,000
1909	1,246,000	1914	1,512,000		
1910	1,128,000	1915	429,000		

The largest output in recent years has been from the Cactus mine; other producers are the Horn Silver, O K, Old Hickory, Milford Copper, and other mines.

Tailings from the old Cactus mill were treated by a flotation plant in 1918.

Clifton district.—The largest producer of this district was the Western Utah Copper Co.

Other districts.—Considerable copper has been produced in the Park City, Big Cottonwood, Little Cottonwood, Ophir, and Rush Valley districts, where the metals of chief value are lead and silver.

OTHER STATES.

Georgia.—In 1918 Georgia produced 397,078 pounds of copper. The productive area is adjacent to the Ducktown (Tenn.) copper district.

Oregon.—Oregon produced 2,630,499 pounds of blister copper in 1918, compared with 1,105,097 pounds in 1917. To the end of 1918 the State has a recorded output of 9,937,632 pounds of copper.

Vermont.—Vermont produced 896,630 pounds of blister copper, the largest production for several years.

Washington.—Washington produced 2,330,568 pounds of blister copper, as compared with 2,051,416 pounds in 1917.

Wyoming.—The production from Wyoming amounted to 866,698 pounds of blister copper as compared with 2,019,767 pounds in 1917.

REFINERY PRODUCTION.

The refinery output of copper in the United States in 1918 was made by 12 plants, 9 of which employed the electrolytic method and 4 employed the furnace process on Lake Superior copper, the Calumet & Hecla plant employing both methods. Six of the large electrolytic refineries are on the Atlantic tidewater, and five Lake refineries are on the Great Lakes. Only two plants are located west of the Great Lakes—one at Great Falls, Mont., and one at Tacoma, Wash. In addition to these refineries there are numerous plants in different parts of the country that make a considerable output from old copper, brass, and other alloys of copper. The output of the regular refining plants is in the form of casting, Lake, and electrolytic copper

CASTING AND PIG COPPER.

Blister copper that is low in precious metals and sufficiently free from impurities for certain uses is refined by the furnace process and ordinarily cast into ingots. This copper is usually unfit for uses requiring a high-grade copper, such as electric transmission, brass manufacture, and rolling, but is suitable for copper castings, and a large part of it is put to that use. Lake copper excepted, a comparatively small percentage of the copper output carries so small a content of precious metals that, together with the added value of electrolytic copper, it will not more than pay for the electrolytic refining of the copper; consequently the output of casting copper is small. Some blister or pig copper low in precious metals has been exported without further treatment and is probably consumed without electrolytic refining. A large percentage of the pig and casting copper shown in the table is from Arizona. Some of the districts produce a rather high grade of blister copper carrying a small amount of precious metals, and it is found profitable to market some of it without electrolytic refining. During 1918 the production of furnace-refined new casting copper amounted to 15,284,635 pounds and of unrefined pig and best select copper to 76,165,976 pounds.

LAKE COPPER.

By Lake copper, as the term is used in this report, is meant the output of the Lake smelters. A considerable portion of this output is refined electrolytically, but most of the electrolytically refined Lake copper is mixed with furnace-refined copper or is sold as some brand of Lake copper. Of the 231,096,158 pounds of copper produced by the Lake smelters, about 56,000,000 pounds was refined electrolytically, either to free the copper from impurities or to recover the silver content.

ELECTROLYTIC COPPER.

Under electrolytic copper, as shown in the accompanying table, is included all new copper that was refined electrolytically, except that from the Lake district that was marketed as Lake copper. In 1918 the production of electrolytic copper from primary materials of domestic origin amounted to approximately 1,560,327,000 pounds, and from materials of foreign origin to 492,181,000 pounds, and in addition 34,674,000 pounds was produced from secondary sources—a total electrolytic production of 2,087,182,000 pounds for the year.

SECONDARY COPPER.

Under secondary copper is considered material recovered from remelting old copper, copper scraps, and copper recovered from the treatment of copper alloys or alloys that are treated without the separation of the copper. A canvass of plants producing secondary copper has been made by J. P. Dunlop, of the United States Geological Survey. Concerning the output of secondary copper Dunlop[1] says:

> The total quantity of secondary copper recovered in 1918, on the assumption that the brass remelted had an average copper content of 70 per cent, was 352,670 short tons, of which 21,846 tons (17,712 tons less than in 1917) was recovered by plants refining primary metals and the remainder by plants treating only secondary materials. The copper produced by smelters of the latter class includes 66,284 tons of pig copper, 34,380 tons of copper in alloys other than brass, and 230,160 tons of copper in remelted brass. These figures indicate a decrease for 1918 of about 22,150 tons of pig copper, an increase of 6,160 tons of copper in brass and of about 3,040 tons in alloys other than brass. At least 176,000 tons was recovered from clean scrap made in the course of manufacture of copper and brass ware, so that less than 177,000 tons was obtained from ashes, cinders, and scrap, or from material that had actually been used and discarded. From the reports received it is quite evident that there was a decrease in the quantity of old copper smelted and that there was not so large a decrease in the quantity of clean new copper and brass scrap remelted. The reports from munition factories show an enormous increase in the quantity of clean scrap remelted, and there was a decrease in the quantity of scrap brass from other users. The quantity of scrap brass used amounted to 328,800 tons, and of this at least 200,000 tons was clean new punchings, filings, and clippings.
>
> It is stated by P. E. McKinney, chemist and metallurgist of the Naval Gun Factory, United States Navy Yard, Washington, D. C., that results obtained from three years operation have shown conclusively that the alloy known as manganese bronze may be made without resorting to the use of high-grade virgin metals. The alloy was produced in a reverberatory furnace from materials which are of low grade, such as yellow brass machine-shop turnings, zinc dross from galvanized pots, aluminum turnings,

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[1] Dunlop, J. P., Secondary metals: U. S. Geol. Survey Mineral Resources, 1918, pt. 1, pp. 593-595, 1920.

old zinc scrap, foundry floor scrap and skimmings, and scrap copper. A description of the material and methods used and the result of tests of the ingots made is given in the Brass World for March, 1919.

The value of the copper, both as metal and in alloys, is computed at the average yearly price of 24.7 cents a pound, the average sales price of all marketable grades of new metal.

According to the Bureau of Foreign and Domestic Commerce the exports for the calendar year 1918 of scrap brass and copper, fit only for remanufacture, were 2,455 tons of scrap brass and 129 tons of scrap copper, and the imports of scrap copper were 959 and of scrap brass 6,114 tons.

Many railways sell or turn in the larger portion of their brass and copper scrap and other metal waste to dealers in part payment for new material; but the reports received show that the railways utilized in their own shops and foundries more than 12,230 tons of brass, in addition to 1,031 tons of copper and 3,573 tons of copper in alloys other than brass. The railway reports, however, frequently include alloys termed brass which should more properly be designated bronze. There was a decrease of about 20 per cent in the quantity of copper and copper alloys used by railways in 1918.

The production of copper from secondary sources in 1918 was equal to about 29 per cent of the refinery output of primary copper in the United States from all sources, or about 37 per cent of the primary copper smelted from domestic ore.

Secondary copper, 1918.

	Short tons.
Copper from scrap, drosses, ashes	88, 130
Copper in alloys other than brass	34, 380
	122, 510
From new scrap	36, 000
From old scrap	86, 510
	122, 510
Brass scrap melted:	
New clean scrap	200, 000
Old scrap	128, 800
	328, 800
Copper content of brass scrap (averaging about 70 per cent copper):	
New scrap	140, 000
Old scrap	90, 160
	230, 160
Total copper produced from secondary sources:	
From new scrap	176, 000
From old scrap	176, 670
	352, 670
Exports of scrap brass in 1918	2, 455
Exports of scrap copper in 1918	129
Imports of scrap brass in 1918	6, 114
Imports of scrap copper in 1918	959

REFINED COPPER.

The total output of new refined copper in 1918 was 2,432,000,000 pounds, an increase of 4,000,000 pounds over that of 1917.

Primary and secondary copper produced by regular refining plants and imported in 1913–1918, in pounds.

	1913	1914	1915	1916	1917	1918
Primary:						
Domestic:						
Electrolytic....	[a]1,022,497,601	[a] 991,573,073	[a]1,114,345,342	[a]1,579,620,513	[a]1,452,744,593	[a]1,560,327,422
Lake...........	155,715,286	158,009,748	[b] 236,757,062	269,794,531	268,508,091	231,096,158
Casting........	22,606,040	21,506,325	21,555,129	12,469,050	69,916,911	15,284,635
Pig and best select........	36,004,986	39,334,043	15,047,990	26,868,105	82,376,576	76,165,976
	[a]1,236,823,913	[a]1,210,423,189	[a]1,387,705,523	[a]1,888,752,199	[a]1,873,546,171	1,882,874,191
Foreign:						
Electrolytic....	[a] 378,243,869	[a] 323,358,205	[a] 246,498,925	[a] 370,635,116	[a] [c] 555,000,000	[a] [c] 492,181,364
Casting and best select...	....	....	....	....	....	57,329,735
	1,615,067,782	1,533,781,394	1,634,204,448	2,259,387,315	2,428,546,171	2,432,385,290
Secondary:						
Electrolytic......	14,862,577	27,702,928	38,156,789	78,585,296	66,337,771	34,674,062
Casting..........	22,360,182	4,224,052	21,417,901	25,838,511	12,779,125	9,018,049
	37,222,759	31,926,980	59,574,690	104,423,807	79,116,896	43,692,111
Total output...	1,652,290,541	1,565,708,374	1,693,779,138	2,363,811,122	2,507,663,067	2,476,077,401

[a] The separation of refined copper into metal of domestic and foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible.

[b] Some Lake copper was refined at seaboard plants and doubtless marketed under some brand other than Lake. This has been excluded from the Lake copper.

[c] Includes refined copper imported.

In addition to the secondary material treated by the regular refining companies, plants that treated secondary material exclusively produced a total of about 661,648,000 pounds of copper as copper and in brass and other alloys of copper, a total production of 705,340,000 pounds from secondary sources. Of this total at least 352,000,000 pounds was produced by remelting clean scrap produced in the manufacture of copper and brass articles.

If the output of plants treating purely secondary material is added to the production of the regular refining companies, the contribution from plants in the United States to the world's supply of copper for 1918 is found to be 3,138,000,000 pounds.

Refined copper produced in the United States, 1906–1918, in pounds.

Year.	From primary sources (domestic and foreign).				From secondary sources (copper and copper in alloys).
	Electrolytic.	Lake.	Casting and pig.	Total.	
1906........................	839,984,614	205,608,382	33,459,413	1,079,052,409	....
1907........................	837,389,422	178,534,141	16,592,684	1,032,516,247	....
1908........................	848,109,132	222,289,584	67,563,692	1,137,962,408	....
1909........................	1,101,894,864	227,005,923	62,120,667	1,391,021,454	....
1910........................	1,128,304,725	221,462,984	72,271,426	1,422,039,135	....
1911........................	1,156,111,987	218,185,236	59,577,803	1,433,875,026	214,000,000
1912........................	1,274,935,371	231,112,228	62,056,879	1,568,104,478	275,000,000
1913........................	1,400,741,470	155,715,286	58,611,026	1,615,067,782	273,000,000
1914........................	1,314,931,278	158,009,748	60,840,368	1,533,781,394	255,764,000
1915........................	1,360,844,267	236,757,062	36,603,119	1,634,204,448	392,374,000
1916........................	1,950,255,629	269,794,531	39,337,155	2,259,387,315	700,000,000
1917........................	2,007,744,593	268,508,091	152,293,487	2,428,546,171	766,800,000
1918........................	2,052,508,786	231,096,158	148,780,346	2,432,385,290	705,340,000

COPPER SULPHATE.

The production of hydrous copper sulphate or bluestone by the copper refineries of the United States in 1918 was 31,292,490 pounds, having a copper content of 7,917,000 pounds, compared with 50,412,325 pounds of bluestone, having a copper content of 12,731,000 pounds in 1917.

STOCKS.

Stocks of copper Jan. 1, 1906–1919, in pounds.

Year.	Refined copper.	Blister and material in process of refining.	Year.	Refined copper.	Blister and material in process of refining.
1906	118,224,028	110,000,144	1913	105,497,683	274,072,084
1907	46,497,181	135,310,239	1914	90,385,402	247,789,811
1908	125,745,796	175,254,659	1915	173,640,501	203,067,571
1909	121,876,759	234,013,843	1916	82,429,666	274,000,000
1910	141,486,244	266,754,808	1917	128,055,229	424,000,000
1911	122,803,656	245,218,530	1918	114,000,000	411,000,000
1912	88,372,195	219,864,749	1919	180,000,000	562,600,000

IMPORTS.

The quantity of copper in unmanufactured form imported into the United States in 1918 was 575,805,115 pounds, according to the records of the Bureau of Foreign and Domestic Commerce. The imports in 1917 were 556,420,297 pounds. The following tables show the character and source of copper-bearing materials imported during 1917 and 1918:

Copper imported into the United States in 1917 and 1918, in pounds.

1917.

Country.	Ore (copper content).	Concentrates (copper content).	Matte and regulus (copper content).	Unrefined black copper and copper in bars, pigs, or other forms.	Refined, in bars, plates, rods, or other forms.	Old and clippings for remanufacture.	Composition metal, copper chief value.
United Kingdom	75,591	....	174,546	....	225	5,550	109,131
Spain	371,902	....	....	....	....	....	....
Canada	31,126,511	38,951	....	40,571,284	765,980	15,321,755	9,801
Mexico	4,929,250	31,502,982	3,736,059	40,213,831	425,532	215,350	4,839
Chile	28,447,728	169,142	15,289,999	162,227,104	4,074,784	158,468	34,659
Cuba	40,100,956	4,913,440	328,966	....	8,590	650,282	186,934
Peru	4,644,455	472,232	768,898	100,302,275	....	90,574	54,465
Japan	....	607,554	....	6,393,524	1,101,776	110	....
Other countries	6,804,139	493,231	750,475	5,890,018	375,071	1,451,505	29,873
	116,500,532	38,197,532	21,048,943	355,598,036	6,751,958	17,893,594	429,702

1918.

Country.	Ore (copper content).	Concentrates (copper content).	Matte and regulus (copper content).	Unrefined black copper and copper in bars, pigs, or other forms.	Refined, in bars, plates, rods, or other forms.	Old and clippings for remanufacture.	Composition metal, copper chief value.
United Kingdom	39,220	....	773,076	112,738	200	300	54,945
Spain	....	....	....	....	....	....	....
Canada	30,060,903	870,066	787,821	37,881,986	4,951,617	935,112	39,210
Mexico	3,373,084	38,867,789	22,638,810	83,568,187	4,244,197	17,682	....
Chile	14,707,473	....	4,239,615	156,285,580	18,264,771	27,506	11,918
Cuba	23,861,119	4,761,704	94,080	....	....	550,164	56,347
Peru	1,200,879	....	2,380,831	81,492,209	8,693,200	6,342	4,259
Japan	....	....	....	827,404	336,022	....	....
Other countries	3,629,335	1,768,315	3,162,361	18,203,547	1,597,762	384,433	40,996
	76,872,013	46,267,874	34,076,594	378,371,651	38,087,769	1,921,539	207,675

Copper (in unmanufactured form) imported into the United States, 1906-1918.

Year	Pounds.	Year	Pounds.	Year	Pounds.
1906	225,593,281	1911	334,607,538	1916	462,335,980
1907	252,620,054	1912	410,241,295	1917	556,420,297
1908	218,705,487	1913	408,778,954	1918	575,805,115
1909	321,801,114	1914	306,350,827		
1910	344,435,771	1915	315,698,449		

EXPORTS.

The exports of metallic copper (exclusive of ore, concentrates, and composition metal) from the United States in 1918 amounted to 744,243,481 pounds, according to the Bureau of Foreign and Domestic Commerce. Exports of copper sulphate were 13,938,819 pounds in 1915, 19,469,565 pounds in 1916, 29,068,748 pounds in 1917, and 14,477,339 pounds in 1918.

Metallic copper exported from the United States, 1906-1918.[1]

Year	Pounds.	Year	Pounds.	Year	Pounds.
1906	454,752,018	1911	786,553,208	1916	784,006,486
1907	508,929,401	1912	775,000,658	1917	1,125,647,336
1908	661,876,127	1913	926,241,092	1918	744,243,481
1909	682,846,726	1914	840,080,922		
1910	708,316,543	1915	681,917,855		

Sulphate of copper (blue vitriol) exported from the United States, 1913-1918.

Year.	Quantity (pounds).	Value.
1913	4,168,675	$211,753
1914	7,387,226	327,967
1915	13,938,819	680,986
1916	19,469,565	2,803,833
1917	29,068,748	3,038,399
1918	14,477,339	1,395,946

Copper exported from the United States.

	1917	1918
	Pounds.	*Pounds.*
Ore (copper content)	5,135,818	2,387,275
Concentrates (copper content)	821,477	872,564
Unrefined black blister and converter copper (bars, pigs, and other forms)	16,992,357	14,687,828
Refined in ingots, bars, rods, or other forms	1,030,779,328	690,027,891
Composition metal, copper chief value	[a] 1,228,082	186,260
Old and scrap	1,070,389	257.403
Pipes and tubes	[a] 7,260,833	4,109,226
Plates and sheets	42,664,931	19,471,584
Wire	26,879,498	15,689,554
	1,132,832,063	747,689,580

[a] Figures cover six months' period beginning July 1, 1917.

The value of the copper exported is stated by the Bureau of Foreign and Domestic Commerce as $146,377,621 in 1913, $117,633,145 in 1914, $117,703,941 in 1915, $206,163,241 in 1916, $338,723,756 in 1917, and $195,840,637 in 1918.

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[1] Does not include ore, concentrates, and composition metal.

Brass exported from the United States in 1917 and 1918.

	1917		1918	
	Quantity.	Value.	Quantity.	Value.
Brass:	*Pounds.*		*Pounds.*	
Scrap and old	8,298,989	$1,758,384	4,909,820	$799,318
Bars, plates, and sheets	328,346,666	101,521,426	30,989,717	9,522,934
Cartridge shells, empty		[a] 3,533,834		566,829
Pipes and fittings	[a] 916,895	[a] 402,167		1,137,336
Wire	[a] 1,804,741	[a] 729,768	1,748,883	707,287
All other manufactures of		131,945,530		17,071,694
	339,367,291	239,891,109	37,648,420	29,805,398

[a] For six months beginning July 1, 1917.

Unmanufactured brass exported from the United States, 1913–1918.

Year.	Brass in bars, plates, sheets, etc.		Year.	Brass in bars, plates, sheets, etc.	
	Quantity (pounds).	Value.		Quantity (pounds).	Value.
1913	6,111,463	$933,949	1916	244,531,706	$72,683,626
1914	7,115,807	909,153	1917	328,346,666	101,521,426
1915	66,272,144	12,435,782	1918	30,989,717	9,522,934

CONSUMPTION.

The apparent consumption of refined new copper in the United States in 1918 was 1,662,000,000 pounds. In 1917 it was 1,395,000,000 pounds. The method employed in determining the quantity of copper retained for consumption is shown in the following table, which does not include stocks of copper held by consumers:

Apparent domestic consumption of refined new copper in 1913–1918, in pounds.

	1913	1914	1915	1916	1917	1918
Total supply of new copper	1,615,067,782	1,533,781,394	1,634,204,448	2,259,387,315	2,428,546,171	2,432,385,290
Stock at beginning of year	105,497,683	90,385,402	173,640,501	82,429,666	128,055,229	114,000,000
Total available supply	1,720,565,465	1,624,166,796	1,807,844,949	2,341,816,981	2,556,601,400	2,546,385,290
Copper exported[a]	817,911,424	748,902,137	588,797,096	734,879,881	1,047,771,685	704,715,714
Stock at end of year	90,385,402	173,640,501	82,429,666	128,055,229	114,000,000	180,000,000
Total withdrawn from supply	908,296,826	922,542,638	671,226,762	862,935,110	1,161,771,685	884,715,714
Apparent consumption	812,268,639	701,624,158	1,136,618,187	1,478,881,871	1,394,829,715	1,661,669,576

[a] Includes unrefined black blister and converter copper (bars, pigs, and other forms) and refined in ingots, bars, rods, or other forms.

If to the 1,662,000,000 pounds of new refined copper is added the 705,340,000 pounds of secondary copper and copper in alloys produced during the year, it is found that a total of about 2,367,000,000 pounds of new and old copper was available for domestic consumption.

Domestic consumption of new copper, 1906–1918.

	Pounds.		Pounds.		Pounds.
1906	677,434,937	1911	681,753,279	1916	1,478,881,871
1907	487,771,625	1912	775,978,332	1917	1,394,829,715
1908	479,955,318	1913	812,268,639	1918	1,661,669,576
1909	688,565,243	1914	701,624,158		
1910	732,405,180	1915	1,136,618,187		

The figures as indicated above do not closely represent the copper that was manufactured in this country for domestic use. The actual domestic consumption for domestic use did not increase in 1915 and 1916 to the extent indicated; the increase represents copper in munitions and other manufactured articles exported. In 1917 and 1918 the manufacture of munitions for the Allied armies was less, but the consumption for our own military needs had greatly increased.

USES.

There are no data available showing the quantity of copper which entered the different industries, and the great changes due to the war render any estimate more uncertain than usual.

The following table shows the copper cast in different forms in 1918. It will be noted that the total is not the same as the production of refined copper:

Copper cast in different forms in 1918.

Form.	Quantity (pounds).	Percentage.
Wire bars	844,323,995	37
Ingots	821,212,629	36
Cakes	289,348,805	13
Cathodes	126,550,857	5
Other forms	213,277,858	9
	2,294,714,144	100

PRICES.

The average price received for copper delivered by the producers in 1918 and the price used by the United States Geological Survey in calculating the value of the copper output was 24.7 cents a pound. The average received by selling agencies for 2,283,500,000 pounds, as reported to the Geological Survey by selling agencies, was 24.683 cents a pound.

The following table shows the average quoted price of copper at New York, as reported by the American Metal Market Co. and by the Engineering and Mining Journal for 1913 to 1918, inclusive:

Average monthly prices at New York per pound of electrolytic copper in 1913–1918, in cents, as reported by the American Metal Market Co.

Month.	1913	1914	1915	1916	1917	1918
January	16.755	14.45	13.71	24.10	30.26	23.50
February	15.27	14.67	14.57	27.46	35.22	23.50
March	14.925	14.335	14.96	27.44	35.74	23.50
April	15.48	14.34	17.09	29.31	32.19	23.50
May	15.63	14.13	18.60	29.81	32.32	23.50
June	14.85	13.81	19.71	27.49	32.57	23.50
July	14.57	13.49	19.08	25.60	28.90	25.89
August	15.68	12.415	17.22	27.36	27.13	26.00
September	16.55	12.085	17.70	28.26	25.45	26.00
October	16.54	11.40	17.86	28.64	23.50	26.00
November	15.47	11.74	18.83	32.22	23.50	26.00
December	14.47	12.93	20.35	33.84	23.50	25.285
Average	15.52	13.315	17.47	28.46	29.19	24.68

Average monthly prices at New York per pound of electrolytic copper in 1913–1918 as reported by the Engineering and Mining Journal.

Month.	1913	1914	1915	1916	1917	1918
January	16.488	14.223	13.641	24.008	28.673	23.50
February	14.971	14.491	14.394	26,440	31.750	23.50
March	14.713	14.131	14.787	26.310	31.481	23.50
April	15.291	14.211	16.811	27.895	27.935	23.50
May	15.436	13.996	18.506	28.625	28.788	23.50
June	14.672	13.603	19.477	26.601	29.962	23.50
July	14.190	13.223	18.796	23.865	26.620	25.90
August	15.400	(a)	16.941	26.120	25.330	26.00
September	16.328	(a)	17.502	26.855	25.073	26.00
October	16.337	(a)	17.686	27.193	23.500	26.00
November	15.182	11.739	18.627	30.625	23.500	26.00
December	14.224	12.801	20.133	31.890	23.500	(b)
Average	15.269	13.602	17.275	27.202	27.180	24.628

[a] Price not quoted. [b] No market.

For 1918 the price was fixed by agreement between the War Industries Board and the copper producers. From January 1 to July 2 it was 23.50 cents a pound; for the remainder of the year it was 26 cents a pound.

LEAD.

By C. E. SIEBENTHAL.

SUMMARY.

The following tabular statement gives the general items regarding domestic production and consumption of refined lead from figures compiled by the United States Geological Survey.

Summary of statistics of refined lead, 1917–18, in short tons.

	1917	1918
PRODUCTION.		
Domestic desilverized lead	303,679	282,024
Domestic soft lead	188,503	210,463
Domestic desilverized soft lead	56,268	47,418
	548,450	539,905
Foreign desilverized lead	62,319	100,290
Total refined primary [a] lead	610,769	640,195
Antimonial lead	18,646	18,570
Secondary [a] lead	93,500	97,100
CONSUMPTION.[b]		
Apparent consumption of primary lead, stocks disregarded	515,535	542,975

[a] "Primary lead," which is produced directly from ore, is here distinguished from "secondary lead," which is obtained by refining skimmings, drosses, and old metals. The statistics of secondary lead are given on p. 944. Wherever in this report the word "lead" is used without qualification it means primary lead.

[b] For method of calculating consumption see p. 969.

The output of refined lead in the United States from domestic ores in 1918 was 539,905 short tons, valued at $76,667,000, at the average price of pig lead in New York, compared with 548,450 tons, valued at $94,333,000 in 1917—a loss in quantity of 8,545 tons, or 1.6 per cent, and a loss in value of $17,666,000, or nearly 19 per cent.

INTRODUCTION.

An estimate of the production of refined lead in 1918 based on reports received from every lead smelter in operation, was published by the United States Geological Survey on January 2, 1919. This estimate included the actual production for the first 10 or 11 months of 1918 and estimates for the remainder of the year. The complete figures for the production and consumption of refined primary lead and for the imports and exports of lead in ore and bullion were given in the preliminary report on the mineral resources of the United States in 1918, published August 7, 1919. The present report contains, in addition to the statistics given in the preliminary report, tables and curves showing production, value, consumption, imports, exports, and prices for a period of years, and embodies certain historical notes on the reaction of the lead industry to the war.

The statistics of production of lead in this country in 1918 have been compiled by the Geological Survey from confidential reports submitted by each lead-smelting company in operation during the year. The statistics of the recovery of secondary lead were also collected by the Geological Survey. The statistics of domestic consumption of refined lead are taken in part from the refinery returns and in part from the records of the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, and the statistics of foreign production are compiled from the sources indicated in connection with the tables here presented.

PRODUCTION.

QUANTITY AND VALUE.

The refined lead produced in the United States from 1720 to 1914 from domestic ores and from foreign ores and base bullion and its value at the average price in New York are shown in a table in the chapter on lead in Mineral Resources for 1914. Details for years later than 1905 are shown in the table below.

Production, price per pound, and value of refined lead in the United States, 1720–1918.

Year.	Desilverized lead.[a], [b]	Soft lead.[c]	Total production.[b]	From domestic ores and base bullion.[b]	From foreign ores.	From foreign base bullion.	Price per pound at New York.[d]	Value.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*		
1720–1905	5,251,079	2,081,836	7,332,915	6,032,383	1,300,532		....	$634,403,000
1906	313,886	90,860	404,746	336,200	28,803	39,743	$0.057	46,141,000
1907	313,588	99,801	413,389	352,381	24,041	36,967	.053	43,819,000
1908	295,552	101,012	396,564	311,666	11,509	73,389	.042	33,311,000
1909	329,751	117,158	446,909	352,839	21,754	72,316	.043	38,434,000
1910	328,954	141,318	470,272	375,402	18,065	76,805	.044	41,384,000
1911	331,032	155,947	486,979	391,995	10,764	84,220	.045	43,828,000
1912	339,646	141,248	480,894	392,517	11,572	76,805	.045	43,280,000
1913	330,593	131,867	462,460	411,878	13,223	37,359	.044	40,696,000
1914	383,903	158,219	542,122	512,794	7,639	21,689	.039	42,286,000
1915	388,594	161,461	550,055	507,026	9,581	33,448	.047	51,705,000
1916	403,619	167,515	571,134	552,228	6,085	12,821	.069	78,817,000
1917	422,266	188,503	610,769	548,450	15,872	46,447	.086	105,052,000
1918	429,732	210,463	640,195	539,905	15,334	84,956	.071	90,908,000
	9,862,195	3,947,208	13,809,403	11,617,664	2,191,739		....	1,334,064,000

[a] Desilverized soft lead is included; for quantity see page 942.
[b] Antimonial lead is excluded; for quantity see page 943.
[c] Desilverized soft lead is excluded.
[d] For 1917 and 1918, average sales price.

PRODUCTION BY MONTHS.

The collection of statistics of the production of lead at short intervals during the period of participation of the United States in the war gives the data for the following table:

Refined primary lead produced in the United States, 1917–18, by months, in short tons.

Month.	1917	1918
January	48,845	48,147
February	41,755	45,427
March	52,438	49,917
April	48,532	49,572
May	56,419	55,232
June	54,509	56,213
July	48,924	54,565
August	49,909	55,174
September	53,512	54,743
October	55,496	61,360
November	51,033	56,194
December	49,397	53,651
	610,769	640,195

In the table given above all secondary lead has been excluded. In the following table, which shows the monthly output of lead, antimonial lead, and bullion of domestic and foreign origin and the quantity at smelters and refineries and in transit, the secondary lead produced at smelters treating ore is not deducted. The totals, therefore, are not comparable with those given in the preceding table. The table below shows the narrow margin of lead on hand at times, and the larger quantities of lead and bullion in transit during the freight congestion in the early part of the year. The quantities of lead given as stocks were of course not free but were either under commitment or under allotment.

Lead, antimonial lead, and bullion produced and in stock in 1918, by months, in short tons.

Month.	Production during month.					Stocks at smelters at end of month.			
	Domestic refined.	Foreign refined.	Antimonial.	Domestic bullion.	Foreign bullion.	Domestic bullion.	Foreign bullion.	Lead in matte, etc.	Lead in ore and concentrates.
January	44,721	4,249	1,483	29,270	2,479	306	3,022	28,583	27,992
February	40,415	5,835	1,099	26,753	2,996	637	3,250	30,933	28,250
March	43,518	7,222	2,779	26,145	4,292	1,412	2,360	29,915	34,239
April	40,473	9,922	3,305	27,100	2,884	887	995	32,821	36,714
May	47,763	8,292	1,746	29,409	5,588	851	489	29,072	36,934
June	47,929	9,107	1,346	24,964	5,938	781	3,202	24,747	41,171
July	46,450	8,938	485	26,098	5,173	1,062	3,103	25,554	42,481
August	47,896	8,101	2,426	25,250	5,759	888	3,364	23,120	40,241
September	47,239	8,327	1,126	23,370	4,181	287	2,718	22,134	38,733
October	53,193	8,990	2,182	24,433	3,705	223	1,477	22,773	32,597
November	48,269	8,748	1,950	23,653	4,688	275	703	21,696	33,209
December	44,704	9,770	1,868	24,958	5,771	150	250	18,898	30,306

Lead, antimonial lead, and bullion produced and in stock, in 1918, by months, in short tons—Continued.

Month.	Stocks at refineries at end of month.							Lead in transit at end of month.			
	Domestic refined.	Foreign refined.	Refined not separated.	Antimonial.	Domestic bullion.	Foreign bullion.	Lead in process and by-products.	Domestic refined.	Foreign refined.	Domestic bullion.	Foreign bullion.
January	9,725	1,732	10,019	1,966	1,842	80	19,235	12,038	....	16,993	13,017
February	7,617	2,621	7,330	1,572	1,373	30	19,992	13,475	84	16,741	12,258
March	6,739	739	3,609	598	7,482	954	19,973	12,407	532	10,953	9,807
April	2,258	1,253	2,945	2,498	6,316	10,341	25,195	9,377	426	6,181	7,330
May	2,760	530	2,813	1,868	6,785	12,013	24,061	10,380	137	9,106	8,009
June	2,275	277	1,720	1,041	6,347	13,269	26,403	8,428	800	8,728	6,058
July	2,346	222	1,450	424	5,290	9,782	29,966	11,695	880	8,408	5,868
August	2,243	....	1,187	899	4,193	10,111	34,465	11,925	....	10,637	5,915
September	3,647	446	744	445	4,401	8,201	36,540	11,340	....	14,876	4,987
October	2,430	....	769	199	1,983	7,163	34,379	12,855	331	12,289	5,222
November	2,510	....	1,092	505	2,256	4,645	34,035	10,573	....	9,766	4,549
December	10,314	193	4,513	1,303	5,135	2,924	35,717	5,932	125	8,797	6,196

PRODUCTION BY STATES.

The production of refined lead can with difficulty be apportioned according to sources of ore, owing to the fact that lead refiners treat products already smelted, whose origin may, as in custom refining, be unknown to them, because the identity of the ore is preserved only as far as the smelter. Accordingly, the following table is compiled, so far as possible, from smelter figures. It includes "pig lead" reported by all known smelters running on Mississippi Valley or southern lead ores and "work lead" produced at all other lead smelters in this country. The greater part of the product reported by smelters operated in conjunction with refineries is stated in terms of refined lead. A like part of the antimonial lead is thus eliminated from the "work lead" produced and appears only in the figures of production of antimonial lead.

In addition to the domestic lead ores smelted in this country, small quantities of domestic lead ore have been exported to smelters in Canada. In 1912 soft lead amounting to 63 tons was smelted from Wisconsin ores at Canadian smelters, and in 1913 soft lead amounting to 37 tons from Wisconsin ores and desilverized lead amounting to 98 tons from Idaho and Washington ores were smelted at Canadian smelters. The desilverized lead smelted in Canada from Washington ores amounted to 31 tons in 1914, to 137 tons in 1915, and to 2,001 tons in 1916. In 1917 silver-lead ores from Idaho and Montana smelted in Canada produced 4,570 tons of lead. Ores from Washington yielded 1,388 tons of lead at Canadian smelters in 1918.

Primary lead smelted or refined in the United States, 1907–1918, by sources, in short tons.

Source of ore.	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Domestic ore:												
Alaska		3	69	75	51	45	6		358	659	884	531
Arizona	2,418	1,464	1,507	948	3,428	3,891	4,901	5,601	6,953	15,328	7,456	6,195
Arkansas[a]	15		14		15			52	51	170	300	14
California	938	515	977	1,207	615	811	3,294	3,698	5,606	3,633	11,471	6,228
Colorado	52,552	28,729	30,865	38,542	30,442	37,039	42,840	41,198	32,352	33,046	29,327	29,395
Idaho	123,292	98,464	103,747	109,951	117,335	127,780	137,802	177,827	160,680	170,059	174,045	142,640
Illinois[a]	498	362	273	263	308	513	619	427	910	670	867	1,010
Iowa[a]	225	110	15					34				
Kansas[a]	1,798	2,293	2,763	1,308	2,522	1,937	1,504	1,043	1,320	1,737	2,663	5,023
Kentucky[a]	75			50		91	16	16	95	37	21	109
Missouri[a]	122,856	122,451	141,105	161,659	182,203	162,610	152,430	194,275	195,634	218,253	218,197	187,743
Montana	2,145	2,320	1,451	1,943	2,484	2,517	3,256	4,386	4,853	4,961	5,933	17,586
Nevada	3,480	3,796	4,792	2,246	1,082	5,699	6,142	5,996	7,664	11,858	12,334	8,726
New Hampshire									3	46		
New Mexico	2,047	586	1,350	1,890	1,371	2,511	1,821	741	2,157	3,290	3,428	5,140
New York												49
North Carolina				2	35	34	10					
Oklahoma[a]	404	1,409	2,268	1,805	1,925	2,500	3,214	3,916	4,346	10,969	19,646	58,755
Oregon	5	7	7		11	21	37	17	11	9		6
South Dakota		13		8	33	12	7	2	5	12	34	28
Tennessee[a]	16								8			843
Texas	12	42	44	36	57	30	108	89	111	26	58	30
Utah	55,540	42,455	66,648	60,605	54,933	60,664	71,069	88,976	106,105	111,789	82,081	76,169
Virginia[a]	83	13		87	400	85	878	143	457	740	147	59
Washington	341	391	120	339	612	53	9	2	11	217	929	906
Wisconsin[a]	3,573	4,013	3,252	3,909	3,966	3,301	2,639	1,819	2,632	3,121	2,930	4,275
Undistributed	896	36	317	101	48	120	63	99	128	113	145	59
Zinc residues	1,890	1,290	1,735	2,237	1,987	3,131	3,765	4,125	4,562	5,478	6,489	5,359
	375,099	310,762	363,319	389,211	405,863	415,395	436,430	534,482	537,012	596,221	579,385	556,878
Foreign ore:												
Africa	288		3,150	3,310	582	1,774	5,976	2,942		328	1,738	1,519
Australia												282
Canada	2,607	162	66	25	122	29	16	2	1,174	1,231	1,100	7,550
Central America	23	12	20	3	28				1	7		
Mexico	20,204	10,145	16,944	11,704	7,333	7,407	4,512	2,386	5,437	1,917	7,607	4,798
South America	919	1,186	1,536	2,996	2,677	2,332	2,617	1,821	2,829	2,366	1,533	1,101
Other foreign		4	38	27	22	30	102	488	140	236	3,894	84
Foreign base bullion:												
Canada	2,716	179	1,500							1,072	6,750	8,108
Mexico	34,251	73,210	70,816	76,805	84,220	76,805	37,359	21,689	33,173	11,598	39,508	76,809
South America									275	151	189	39
	61,008	84,898	94,070	94,870	94,984	88,377	50,582	29,328	43,029	18,906	62,319	100,290
Grand total	436,107	395,660	457,389	484,081	500,847	503,772	487,012	563,810	580,041	615,127	641,704	657,168

[a] The lead produced by these States is nonargentiferous or soft lead.

SOFT LEAD.

The lead ores of the Mississippi Valley are almost free from silver and the lead produced from them is known as "soft lead."

A little lead ore of this kind is also mined in Washington and other Western States, but this ore has been generally smelted by plants treating argentiferous lead ore, and thus the resulting lead has not been distinguished from the desilverized product of those plants. With two exceptions, the smelters running exclusively on these soft-lead ores do not desilverize their product. Their output is shown in the column headed "Soft lead" in the table on page 938, giving the production of refined lead for 1720–1918. However, considerable soft-lead ore has been annually smelted and some purchased soft pig lead has been desilverized by the silver-lead smelters. Since 1904 the St. Louis Smelting & Refining Co. has regularly desilverized its product. In 1915 the St. Joseph Lead Co. installed desilverizing kettles, and a part of its product has since been desilverized. This desilverized soft lead, for the years prior to 1906, has not been recorded separately from the lead produced from silver-lead ores, though the lead content of the soft-lead ores so smelted and desilverized has been recorded since 1894. Since 1906 the quantity of soft lead produced by each State has been recorded, as shown in part in the preceding table. In the following table the undesilverized output of the soft-lead smelters is given in the first column and the refined lead output from soft-lead ores smelted and desilverized is given in the second column. The figures do not give the total quantity of lead recovered from soft-lead ores, for the lead recovered in the form of pigments, which are made principally from soft-lead ores, should be taken into account. The lead content of pigments smelted directly from ore in 1918 is given in the fourth column, and the total output of soft lead in the fifth column. The percentage which the total production of soft lead makes of the total domestic production of lead, composed of refined domestic lead plus lead in pigments and lead in antimonial lead, is shown in the last column. As will be noted, the percentage ranges from 37 to nearly 50 in the period under review. A little foreign lead is incorporated in the lead content of the leaded zinc pigment, but as it is difficult to determine just what quantity is involved it has been disregarded.

Soft lead produced in the United States, 1907–1918, in short tons.

Year.	Soft pig lead.			Soft lead recovered in pigments.	Total soft lead.	Total domestic lead.[a]	Soft lead percentage of total domestic lead.
	Undesilverized.	Desilverized.	Total soft pig lead.				
1907	99,801	29,829	129,630	6,574	136,204	365,506	37
1908	101,012	29,869	130,881	7,377	138,258	326,657	42
1909	117,158	32,532	149,690	7,292	156,982	367,393	43
1910	141,318	27,952	169,270	7,603	176,873	391,543	45
1911	155,947	35,667	191,614	7,678	199,292	407,767	49
1912	141,248	29,789	171,037	10,323	181,360	410,159	44
1913	131,867	29,433	161,300	10,998	172,298	435,343	40
1914	158,219	43,506	201,725	11,914	213,639	537,676	40
1915	161,461	44,001	205,462	12,782	218,244	536,312	41
1916	167,515	68,244	235,759	13,252	249,011	580,225	43
1917	188,503	56,268	244,771	12,870	257,641	574,338	45
1918	210,463	47,418	257,881	13,093	270,974	562,218	48

[a] Includes domestic refined lead, domestic lead in antimonial lead, and domestic lead in pigments.

ANTIMONIAL LEAD.

The production of by-product antimonial lead from argentiferous lead ores derived from all sources, as reported by all lead refineries operating in this country, is shown for the period 1871–1906 (earlier years being estimated from the output of desilverized lead) in a table in the chapter on lead in Mineral Resources, 1914. The figures for later years are given in the table below. Since 1909 producers have been asked to distinguish between the by-product antimonial lead derived from ore and bullion of foreign origin and that from domestic ores. Inasmuch as the antimonial skimmings are worked up in batches, the output of antimonial lead in any one year does not necessarily correspond strictly to the bullion refined during that year, hence the output of antimonial lead is distributed as between domestic and foreign in proportion to the lead refined from domestic and from foreign bullion during the year. The total antimonial lead produced during the period 1907–1918 was equal to 5.13 per cent of the total lead refined from domestic and foreign bullion during that period.

By-product antimonial lead produced in the United States, 1907–1918.

Year.	Total lead refined from base bullion (short tons).	Percentage of by-product antimonial lead.	Antimonial lead.						
			From domestic ore (short tons).	From foreign ore (short tons).	Total.				
					Quantity (short tons).	Value.	Antimony content.		Lead content, by difference (short tons).
							Short tons.	Percentage.	
1907	283,759	3.5	7,780	2,130	9,910	$1,322,985	1,561	15.8	8,349
1908	265,683	5.1	9,274	4,355	13,629	1,264,771	2,440	17.9	11,189
1909	297,219	4.3	8,889	4,007	12,896	1,231,019	2,360	18.3	10,536
1910	301,002	4.7	10,140	3,929	14,069	1,338,090	2,229	15.8	11,840
1911	295,365	4.8	9,636	4,442	14,078	1,380,556	2,254	16.0	11,824
1912	309,857	4.4	8,549	5,003	13,552	1,311,348	1,949	14.4	11,603
1913	301,160	5.5	14,667	1,998	16,665	1,591,854	2,508	15.0	14,157
1914	340,397	4.9	15,475	1,192	16,667	1,572,167	2,693	16.2	13,974
1915	344,593	6.7	19,371	3,853	23,224	3,665,736	3,425	14.8	19,799
1916	335,375	7.2	17,246	6,792	24,038	4,483,582	3,496	14.5	20,542
1917	365,998	5.1	15,279	3,367	18,646	3,781,560	2,759	14.8	15,887
1918	382,314	4.9	10,777	7,793	18,570	2,826,350	2,566	13.8	16,004
Average		5.13						15.4	

Details of the production and consumption of antimony in the United States are given in the chapter on antimony in Mineral Resources, 1918.

LEAD PIGMENTS.

PIGMENTS SMELTED DIRECTLY FROM ORE.

In addition to leaded zinc oxide and zinc-lead oxide, which are noted more particularly in connection with the production of zinc pigments, two other lead pigments are made directly from ore, namely, sublimed white lead and sublimed blue lead. Sublimed white lead consists of lead sulphate 75 per cent, lead oxide 20 per cent, and zinc oxide 5 per cent. Sublimed blue lead consists of lead sulphate 50 to 53 per cent, lead oxide 41 to 38 per cent, with small proportions of lead sulphide, lead sulphite, and zinc oxide. Zinc-lead oxide contains from 46 to 50 per cent of lead sulphate, from 52 to 46 per cent of zinc oxide, and a small quantity of zinc sulphate. No zinc-lead oxide is made at present. Leaded zinc oxide may vary from 4 to 20 per cent in lead sulphate, the remainder being zinc oxide, with a small portion of zinc sulphate.

The lead content of pigments smelted directly from ore is given in the fourth column of the table on page 942. As there are but two producers of sublimed lead or basic lead sulphate, the output may not be revealed. The production of leaded zinc oxide is given in the chapter on zinc.

PIGMENTS MANUFACTURED FROM PIG LEAD.

Manufactured lead pigments sold in 1917–18.

Pigment.	1917			1918		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
Basic carbonate white lead:						
In oil	87,331	$17,608,967	$201.63	82,799	$17,224,480	$208.03
Dry	27,869	4,920,864	176.57	20,089	3,542,368	176.33
Red lead Orange mineral	25,478	5,523,018	216.78	30,069	5,928,597	197.17
Litharge	44,102	8,611,074	195.25	48,874	8,825,724	180.58
	184,780	36,663,923	....	181,831	35,521,169	....

SECONDARY LEAD.

Secondary lead is obtained mainly from skimmings, drosses, old metal, and alloys, such as babbitt, solder, and type metal. The recovery of lead by refining these materials constitutes an integral part of the lead industry. This business is carried on mostly at small refineries scattered over the United States, but the large smelters and refineries working primary lead frequently find it advantageous to incorporate material from secondary sources. The product of such secondary refineries is of two classes—pig lead and lead in alloys. The lead in alloys may have been recovered in the form of pig lead and alloyed at the refinery, or it may have been refined as an alloy, being brought to the desired composition by the addition of the requisite metal.

Secondary lead recovered in the United States, 1909–1918, in short tons.

Year.	Pig lead.	Lead in alloys.	Total recovered lead.	Value.
1909	18,360	23,327	41,687	$3,585,000
1910	29,492	25,930	55,422	4,877,000
1911	27,389	26,895	54,284	4,886,000
1912	30,266	36,902	67,168	6,045,000
1913	33,104	39,730	72,834	6,409,000
1914	29,337	31,725	61,062	4,763,000
1915	36,400	42,500	78,900	7,416,000
1916	56,700	39,600	96,300	13,289,000
1917	45,100	48,400	93,500	16,082,000
1918	41,146	55,954	97,100	13,788,000

MINE PRODUCTION.

The preceding tables give the quantity of lead recovered by smelting and refining operations either as metallic lead, or in the alloy antimonial lead, or as lead in pigments. The three following tables show the source or derivation of the domestic lead that is recovered by smelting and refining operations. The origin of the lead is much more accurately shown by the mines reports, because smelters necessarily treat mixtures of ores, sometimes long after they have been received, so that the actual output of metallic lead may not correspond at all closely to the product of the mines for the same year. The data for these tables are taken from the chapters on gold, silver, copper, lead, and zinc in the Eastern, Central, and Western States.

It should be understood that strict comparisons between the States are not possible, because the form of statement is not uniform, the lead being stated as recovered lead in some States, lead content in others, and as partly one and partly the other in still other States. It is hoped that this practice, which is largely necessitated by conditions, can be soon abandoned in favor of stating the lead as recovered metal.

MINE PRODUCTION, 1907–1918.

The following table gives the output of lead since 1907, the first year in which there were mines reports for all lead-producing States. Missouri holds first rank in mine production of lead throughout the period, with Idaho in second and Utah in third place. Colorado held fourth place until 1918 when Oklahoma went into that rank.

Mine production of lead by States, 1907–1918, in short tons.

State.	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Alaska	....	....	19	28	24	....	18	28	437	820	852	564
Arizona	2,339	1,504	1,549	1,348	5,137	3,403	8,072	7,502	10,869	13,531	11,733	6,252
Arkansas	12	15	24	63	64	31	18	41	63	272	382	120
California	1,313	619	751	1,435	699	572	1,757	2,126	2,290	6,204	10,934	6,686
Colorado	42,703	26,100	36,084	38,036	34,840	37,621	43,949	37,106	34,405	35,457	33,995	32,980
Idaho	116,912	103,414	107,993	114,129	136,278	142,093	158,936	174,263	173,000	187,541	196,780	147,348
Illinois	830	399	295	373	964	1,282	959	717	954	1,072	1,439	2,273
Iowa	242	51	36	20	60	63	65	....	....	14	34	....
Kansas	2,555	2,518	1,300	2,412	2,859	2,371	2,427	1,409	1,212	1,648	3,025	7,262
Kentucky	34	....	10	41	....	106	22	16	251	153	123	185
Missouri	138,675	144,459	159,435	161,016	178,868	177,069	176,116	192,612	210,440	233,088	234,156	194,175
Montana	1,874	2,298	1,492	2,053	3,216	3,723	5,468	4,828	6,878	6,798	10,976	18,568
Nevada	3,136	3,623	4,920	2,436	1,632	9,750	8,172	6,405	8,319	12,819	13,839	11,658
New Hampshire	....	....	....	....	....	....	....	....	3	47	48	30
New Mexico	1,905	437	2,515	2,160	1,483	2,747	1,973	882	2,271	4,107	4,554	4,199
New York	....	....	....	....	....	....	....	....	....	....	....	29
North Carolina	....	....	....	....	....	46	....	....	....	....	1	....
Oklahoma	532	1,781	3,427	2,888	2,501	3,388	6,228	7,556	7,306	12,115	26,358	56,097
Oregon	....	1	....	....	....	20	44	8	31	14	....	5
Pennsylvania	....	....	....	....	....	....	....	....	6	....	....	....
South Dakota	....	12	59	7	32	11	5	2	2	18	34	27
Tennessee	....	....	....	....	....	....	....	....	1	16	2,531	1,705
Texas	12	33	46	33	61	33	113	75	110	25	1	13
Utah	57,969	44,389	74,243	61,662	68,248	70,156	83,063	85,662	99,984	100,745	[illegible],261	83,504
Virginia	70	38	....	99	417	235	816	127	339	728	859	815
Washington	410	575	144	661	424	64	101	33	148	2,700	4,895	2,636
Wisconsin	3,499	4,138	3,694	4,413	3,353	2,581	1,866	1,494	2,322	3,043	4,139	4,533
	375,013	336,404	398,036	395,313	441,160	457,365	500,188	522,892	561,641	622,975	650,949	581,654

MINE PRODUCTION BY KINDS OF ORE.

The following table shows for each lead-producing State the total quantity of lead-bearing ores produced and the output of each kind of lead-bearing ore. The column headed "All other ores" includes copper ore, copper-lead ore, and dry or siliceous ore. "Dry" ores produced in Colorado contained 8,538 short tons of lead, and in Nevada, 2,914 tons. This lead, as in other States, was concentrated from parts of the ore from certain counties, however, and was not distributed through the whole of the "All other ore" credited to Colorado and Arizona.* The total crude ore yielding either gold, silver, copper, lead, or zinc is given for each lead-producing State, so that a comparison may be made of the relative extent of deep-mining operations in these States, of which the quantity of crude ore raised is the best measure. As shown by the table, Missouri takes a dominating position in the production of crude lead ore, having produced 70 per cent of the crude lead ore mined in the United States in 1918. Oklahoma raised nearly 40 per cent of the crude lead-zinc ore mined in 1918. Missouri, which for many years had held first place in the output of crude ore carrying any or all of the five metals mentioned, gave way to Arizona, Utah, and Michigan with their large production of low-grade copper ore.

The table gives the quantity of lead contained in the crude ores of each State in 1918 and the lead content of each kind of lead-bearing ore. The percentage of lead contained in the lead ore, the lead-zinc ore, and the zinc ore of each State is also given. The lead content of lead ore, in States having a considerable production, ranged from 32.3 per cent in Washington down to 3.3 per cent in Missouri; the average for all the States was 5.2 per cent. The lead-zinc ores were much less rich in lead than the lead ores, averaging 1 per cent. The average lead content of the zinc ores was 0.1 per cent. Of the total mine production of lead in 1918, a quantity corresponding to 71.1 per cent was derived from lead ores, 26.2 per cent from lead-zinc ores, 0.2 per cent from zinc ores, and 2.5 per cent from all other ores. The figures of mine production of lead are taken from the chapters on gold, silver, copper, lead, and zinc in the various States, as indicated in the prefatory note.

Mine production of lead in the United States in 1918, by States and kinds of ore, in short tons.

State.	Lead ores.			Lead-zinc ores.			Zinc ores.			All other ores.		Total.	
	Crude ore.	Lead content.		Crude ore.	Lead content.		Crude ore.	Lead content.		Crude ore.	Lead content.	Crude ore.	Lead content.
		Quantity.	Percentage		Quantity.	Percentage		Quantity.	Percentage				
Alaska										2,817,624	564	2,817,624	564
Arizona	79,811	5,710	7.2	13,043	404	3.1	2,129	18	0.8	18,943,503	120	19,038,486	6,252
Arkansas							37,000	120	.3			37,000	120
California	38,746	6,247	16.1				17,349	29	.2	2,447,316	410	2,503,411	6,686
Colorado	183,274	16,578	9.0	291,196	7,002	2.4	60,350	862	1.4	1,780,070	8,538	2,314,890	32,980
Idaho	1,420,878	131,446	9.3	490,917	15,803	3.2	5,506	90	1.6	174,318	9	2,091,619	147,348
Illinois				280,900	2,273	.8						280,900	2,273
Kansas				1,025,400	7,252	.7						1,025,400	7,252
Kentucky							[a] 3,150			(b)	185	[a] [b] 3,150	185
Missouri	5,532,600	181,392	3.3	3,614,200	12,783	.3						9,146,800	194,175
Montana	31,423	3,269	10.4	1,090,955	15,240	1.4	1,873	1	.1	6,699,716	58	7,823,967	18,568
Nevada	48,169	6,486	13.5	23,246	2,203	9.5	10,977	55	.5	6,390,187	2,914	6,472,579	11,658
New Hampshire				75	30	40.0						75	30
New Mexico	17,945	3,098	17.3	13,933	569	4.1	110,213	2		4,607,693	530	4,749,784	4,199
New York	43	29	67.4				40,850					40,893	29
Oklahoma				5,754,700	56,097	1.0						5,754,700	56,097
Oregon	2	1	50.0							126,679	4	126,681	5
South Dakota	357	27	7.6							1,782,206		1,782,563	27
Tennessee				32,217	1,705	5.3	598,742			529,012		1,159,971	1,705
Texas	49	13	26.5							50,543		50,592	13
Utah	527,759	56,759	10.8	428,985	25,571	6.0	1,849	3	.2	13,747,125	1,171	14,705,718	83,504
Virginia				25,908	815	3.1						25,908	815
Washington	8,125	2,624	32.3							130,786	12	138,911	2,636
Wisconsin				2,377,300	4,533	.2						2,377,300	4,533
	7,889,181	413,679	5.2	15,462,975	152,280	1.0	839,088	1,180	.1	60,226,778	14,515	84,468,922	581,654
Percentage of total lead derived from each kind of ore		71.1			23.2			.2			2.5		100.0

[a] Estimated.

[b] By-product from unknown quantity of fluorspar ore.

MINE PRODUCTION BY DISTRICTS.

The next table shows the mine production of lead by individual districts so that they may be compared as to extent of mining operations, shown by the output of crude ore, as to character of ores, whether sulphide or oxidized, whether lean or rich, and as to relative rank as lead producers.

Mine production of lead in districts producing more than 1,000 short tons each in 1918, in short tons.

District.	State.	Crude lead-bearing ore sold or treated.	Shipping ore and concentrates.					Lead content of siliceous ore, iron ore, zinc ore, etc.	Total lead content.	Percentage of total production.
			Total quantity.	Sulphides.		Carbonates.				
				Quantity.	Lead content.	Quantity.	Lead content.			
Southeastern Missouri	Missouri	5,532,600	271,506	271,506	181,392				181,392	31.2
Coeur d'Alene	Idaho	1,840,954	400,547	400,547	139,110			197	139,307	23.9
Joplin	Southwestern Missouri	3,614,200	16,477	16,468	12,778	9	5		76,132	13.1
	Southeastern Kansas	1,025,400	9,083	9,083	7,252					
	Northeastern Oklahoma	5,754,700	69,912	69,912	56,097					
West Mountain (Bingham)	Utah	411,784	235,055	234,993	39,726	62	16	145	39,887	6.9
Tintic	do	128,908	128,780	13,822	2,418	114,958	12,908		15,326	2.6
Park City	do	136,281	58,356	38,715	7,854	19,641	3,752	554	12,160	2.1
Butte	Montana	996,857	109,397	109,397	8,612			2,761	11,373	2.0
Leadville	Colorado	332,181	236,974	191,466	4,954	45,508	5,722	510	11,186	1.9
Ophir and Rush Valley	Utah	77,240	47,275	42,698	5,493	4,577	963		6,456	1.1
Upper Mississippi Valley	Wisconsin	2,377,300	6,210	6,210	4,533				5,946	1.0
	Northern Illinois	280,900	1,868	1,868	1,413					
	Iowa									
Aspen	Colorado	98,300	60,158	60,158	5,833				5,833	1.0
Pioche	Nevada	17,435	5,968	4,671	813	1,297	148	2,706	3,667	.6
Troy	Montana	65,342	8,738	8,738	3,410				3,410	.6
Yellowpine	Nevada	29,894	15,278	2,532	1,340	12,746	1,696	194	3,230	.6
Big Cottonwood and Little Cottonwood	Utah	21,842	20,907	2,104	199	18,803	2,748	57	3,004	.5
Keeler	California	17,839	17,839	17,839	2,989				2,989	.5
Animas	Colorado	69,534	12,790	12,790	2,876				2,876	.5
San Francisco	Utah	58,982	26,436	14,728	1,420	11,708	1,430		2,850	.5
Upper San Miguel	Colorado	371,073	27,763	27,763	2,807				2,807	.5
Northport	Washington	7,550	7,550	915	632	6,635	1,878		2,510	.4
Texas	Idaho	8,706	8,706	30	4	8,676	2,495		2,499	.4
Porthill	do	27,959	3,613	3,613	2,198				2,198	.4
Eureka	Colorado	63,382	9,287	9,287	1,867				1,867	.3
Warren	Arizona	32,571	8,161	2,926	938	5,235	925		1,863	.3
East Tennessee	Tennessee	32,217	2,880			2,880	1,705		1,705	.3
Mineral Creek	Arizona	6,386	6,386			6,386	1,634		1,634	.3
Ward	Nevada	9,268	9,268			9,268	1,536		1,536	.3
Magdalena	New Mexico	20,270	20,270	14,777	679	5,493	838		1,517	.3
Red Cliff	Colorado	88,920	62,004	62,004	1,464				1,464	.3

Smelter [a]	Utah	99,159	13,908	13,808	1,441	100	9		1,450	.2
Central	New Mexico	8,429	8,429	4,941	473	3,488	956		1,429	.2
Tecopa	California	11,361	11,361	11,361	1,408				1,408	.2
Colorado	Montana	12,136	12,136	12,136	1,127				1,127	.2
Warm Springs	Idaho	22,269	7,185	6,924	1,009	261	73		1,082	.2
Kentucky-southern Illinois	Kentucky and Illinois	(b)	1,483	1,483	1,045				1,045	.2
		23,710,129	1,979,944	1,702,213	507,604	277,731	41,437	7,124	556,165	95.6
All other districts									25,489	4.4
Total for United States									581,654	100.0

[a] Old tailings largely from Bingham ores reconcentrated at Midvale.

[b] Mainly by-product of fluorspar mining.

COMPARISON OF TOTALS BASED ON SMELTER RETURNS AND ON MINE RETURNS.

The two sets of statistics of the production of lead as shown in the foregoing tables (the statistics of lead actually recovered by the smelters as refined pig lead, as antimonial lead, and in pigments, and the statistics of mine production—that is, of the lead content of ores produced) are compared over a period of years in the following table:

Comparison of totals compiled from smelter and from mine reports, 1907–1918, in short tons.

Year.	From smelter reports.	From mine reports.	Smelter excess.	Mine excess.
1907	365,506	375,013	....	9,507
1908	326,657	336,404	....	9,747
1909	367,393	398,036	....	30,643
1910	391,543	395,313	....	3,770
1911	407,767	441,160	....	33,393
1912	410,159	457,365	....	47,206
1913	435,343	500,188	....	64,845
1914	537,676	522,892	14,784	....
1915	536,312	561,641	....	25,329
1916	580,225	622,975	....	42,750
1917	574,338	650,949	....	76,611
1918	562,218	581,654	....	19,436
	5,495,187	5,843,590	....	348,453

The smelter totals represent actual recovery and are found by summing up the total production of refined lead reported by all companies, by calculating the lead content of domestic antimonial lead, and recalculating all pigments back to equivalent metallic lead on the basis of average analysis of product. The lead recovered from secondary sources is excluded from these totals, as it has already been reckoned once as pig lead. In collecting the data for compiling the mine totals, each producing property is requested to report the actual tonnage of lead ores and concentrates shipped, and from this tonnage the lead content is reckoned by assay value. The quantities thus obtained from all the producing properties in each State are combined to make the total. It is clear that by either method the correctness of the totals is dependent upon complete and correct returns from every producing mine and smelter. It is further essential to the correctness of the mine totals that the assay content be correctly estimated.

With equal conditions affecting the mines and the smelters, the stocks in the ore bins of the smelters should run about even from year to year, and the mine and smelter totals, allowance being made in the former for losses in smelting, should show reasonable agreement. As may be seen from the table, however, there are frequent irregularities in the mine-excess column. The causes of these irregularities fall into four categories. The first is lag, by which is meant the time that elapses between the shipment of ore by the mine and the reduction of the ore by the smelter. This is frequently considerable, for ore raised near the end of the year may remain in the stock bins of the smelter until the succeeding year, and, unless balanced by an equivalent lag from the preceding year, will thus lead to an apparent "mine excess." If through accident, business depression, or otherwise the mines close down, the smelters largely consume their stocks of ore, and the result may be an apparent "smelter excess." The second source of difference is found in error in the mine totals in the arbitrary calculation of metal content from assay. The dry assay in vogue in the Western States gives results uniformly too low. A decision of the United States circuit court (T. D. 21653) recognizes a differential of 1.5 per cent between the dry assay and chemical analysis, and in actual practice the discrepancy is probably even greater than that. Lastly, these totals do not take into account, except in certain of the Western States, the loss in smelting, ranging from 2 to 5 per cent in the treatment of easily reducible ores and reaching 10 per cent or more in the more refractory ores. Wastage running over 20 per cent is allowed by the Treasury Department in smelting in bond foreign lead ores running high in antimony and arsenic. Lag being left out of account, the totals would normally show a mine excess equal to the smelting loss. Any discrepancy that appears in the table may reasonably be ascribed to one or more of these items. In the long run, barring error and allowing for smelting losses and exportation of ore, the "mine excess" will be balanced by equivalent "smelter excess."

By referring to the table comparing the mine and smelter totals, it will be seen that once during the last 12 years the production of lead by the mines has been less than the output of the smelters. In the other years the mine production has been considerably in excess. The total output of lead in refined lead, antimonial lead, and pigments by the smelters during the 12 years was 5,495,137 tons, and the output of the mines for the same period was 5,843,590 tons, the excess of mine production over smelter production being 348,453 tons.

SMELTER CHANGES.

The Ontario Smelting Co. (Inc.) completed and operated a soft-lead smelter at the village of St. Louis, Ottawa County, Okla. The plant is equipped with four Newnam automatic-rabbling ore hearths, a lead stack, refining kettles, and a baghouse. The Eagle-Picher smelter at Galena, Kans., was doubled in capacity in the later part of 1917 and the early part of 1918. It is now equipped with eight Newnam automatic ore hearths. The Mineral Point Zinc Co. erected, late in 1917, a blast furnace to handle lead ores and leady zinc-retort residues, which was operated through 1918. The Flint Mill & Furnace Co. erected a 20-ton Fink furnace at Wauwatosa, near Milwaukee, Wis. This was operated in 1918 in an experimental way on lead concentrates from the upper Mississippi Valley district.

THE LEAD INDUSTRY AND THE WAR.

Under this heading will be given a brief account of the war's demands upon the lead industry of the United States, how they were met, and the organization machinery through which they were met. The duration of the war is naturally divided into two periods—that before the United States entered the war and that afterward.

FIRST PERIOD.

During the first period the United States was called on to meet the increased demand for lead caused by the war. The development of this demand was surprisingly slow and the price of lead was not materially enhanced until nearly the middle of 1915; in fact the lowest price in years, 3.5 cents a pound, was reached in October, 1914. After 1915 the price of lead rose higher and higher, with increasing scarcity and greater demand, until it reached the maximum for the war, 12.25 cents a pound, about the middle of June, 1917. Although the foreign demand in 1914 was not materially larger than the average for several years prior to that time, nevertheless the burden on the lead-mining industry of the United States was greater because the imports of lead in ore and bullion from Mexico were cut that year to about one-fourth the average of years preceding the internal dissensions in that country, and the difference had to be made up by the United States. Exports of domestic pig lead were made for the first time in 1914; they have since continued and seem likely to be kept up so long as labor troubles reduce the output of lead in Spain and prevent the shipment of lead from Australia.

SECOND PERIOD.

WORK OF THE VARIOUS ORGANIZATIONS.

With the entry of the United States into the war came a more strenuous phase. The lead industry set itself grimly and patriotically to the task of helping to win the war. Committees, including representatives of all the important lead producers, cooperated with the Government war boards and commissions to the end that production might be stimulated, waste be avoided, and the necessary quantity of lead be reserved for the needs of the Government. The Joint Information Board, composed of representatives of the Government bureaus and the war boards and commissions, maintained the contact between them necessary to prevent duplication of effort and loss of time. Excerpts from official reports detailing the war activities of the lead producers' committees and the War Industries Board are given on pages 955–960.

UNITED STATES GEOLOGICAL SURVEY.

During the first period the United States Geological Survey limited its efforts to publishing the usual statistics of domestic smelter production and foreign commerce in lead and to furnishing information on resources. During the second period the Survey was called upon by the War Industries Board for statistics at shorter intervals, and therefore statistics of the production, stocks, and commitments of refined lead and by-product antimonial lead were collected weekly by wire and furnished to the board. Monthly figures, with more time allowed for refinement of detail, were likewise collected during 1918, and the War Industries Board was furnished with a monthly statement showing the output of foreign and domestic refined lead, antimonial lead, and base bullion, the smelter stocks of foreign and domestic bullion and lead in matte and in ore and concentrates, the refinery stocks both of domestic and foreign refined and antimonial lead and base bullion, stocks of lead in process and in by-products, and the quantity of lead of each class in transit at the end of the month. The last item was included on account of the situation which arose during the traffic congestion of 1917, when eastern refineries were restricted in output because of delays in transportation of base bullion. Details of stocks of refined lead, bullion, and by-products became necessary because the great scarcity of lead compelled its practical rationing to consumers in the later part of 1918.

From time to time during the second period the Geological Survey was called upon for special reports on output or resources of lead by the Council of National Defense, the War Industries Board, the War Trade Board, the Shipping Board, the War Department, the Navy Department, and other organizations having to do with the conduct of the war.

WAR-SERVICE COMMITTEES OF THE UNITED STATES LEAD PRODUCERS.

A historical sketch[1] of the service of these committees, which covered practically the whole period of the participation of the United States in the war, is freely quoted below as giving a picture of the lead industry from the producers' point of view:

> On April 6, 1917, war on Germany was declared by the United States. On the same day, at the call of Mr. Bernard M. Baruch, then chairman of the committee on raw materials, minerals, and metals, of the advisory commission of the Council of National Defense, there was held in New York a meeting of representatives of several of the leading lead-producing companies. At this meeting Mr. Baruch appointed the following to serve as the committee on lead of the advisory commission of the Council of National Defense:
>
> Clinton H. Crane, chairman, St. Joseph Lead Co.
> F. W. Bradley, Bunker Hill & Sullivan Mining & Concentrating Co.
> Edward Brush, American Smelting & Refining Co.
> E. J. Cornish, National Lead Co.
> F. Y. Robertson, U. S. Smelting, Refining & Mining Co.
> Harry L. Day, Pennsylvania Smelting Co.
> Irwin H. Cornell, secretary.
>
> The initial problem consisted in the determination of the means to be adopted for the furnishing of the pig lead required for direct use by the Government, including that needed for war contracts for which the Government had agreed to supply the raw materials. It was at once evident that the amount of lead thus needed could not be made available without a partial abrogation of existing contracts between producers and commercial consumers, and also that the producers themselves could not furnish it at a fixed price less than the current market without grave injustice to certain of them who derived all or part of their output from custom ores, purchased on the basis of average monthly price contracts.
>
> At the outset it was estimated that as soon as the lead-consuming industries of the country had been put on a war basis, the lead required by the Government would amount to one-sixth to one-fifth of the domestic production. The market price of pig lead early in April, 1917, was well over 9 cents per pound New York. In order to insure the Government its requirements at a figure both reasonable and independent of any market price made inflated by unprecedented demand and to equitably distribute participation in the Government purchases, it was proposed by the committee that a specified proportion of the country's production should be set aside for shipment to Government order, at a price of 8 cents per pound f. o. b. East St. Louis, and that all mining companies should be requested to contribute on this basis the same proportion of their output, whether they were large producers operating their own smelters and refineries or smaller concerns who shipped ores or concentrates to custom smelters.
>
> Mr. Baruch agreed to this proposal, and Mr. Clinton H. Crane, chairman of the committee, thereupon accordingly undertook to obtain on the basis of the 8-cent

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[1] A brief history of the war-service committees of the United States pig-lead producers, 1917-18, New York, 1919.

East St. Louis price, the 8,000 tons for July shipment, which it was then estimated the Government would require for that month. This tonnage represented aproximately one-sixth of the monthly domestic production.

It was realized that universal participation could not be obtained, and therefore a few of the larger producers underwrote the full 8,000 tons themselves, thus making it available for July shipment, prior to receipt of advices from custom smelters of total tonnage of lead content settled for on the 8-cent basis in accordance with the authorizations of the shippers.

Generally speaking, the response to the appeal was gratifying. With one exception, all of the larger producers immediately agreed to the one-sixth participation, as did ultimately the majority of the smaller shippers, in spite of the fact that the commercial lead price ranged from 10 to 12 cents per pound during June and July. Nevertheless, as had been anticipated, refusal to participate by some companies necessitated the contribution at the 8-cent price by those producers who had underwritten the sale of more than one-sixth of their July production.

During the latter part of June, the secretary of the committee began to allot the Government's shipping orders among the producers of refined pig lead. Advices were received by the committee from the various Government departments and from Government contractors, of the tonnage required in each case for July shipment. In order to maintain the usual procedure of commercial business, it was arranged at the start that in so far as possible, the lead should be paid for by the contractor, who would be reimbursed by the Government in accordance with the terms of the allotment. Copies of allotments were invariably forwarded to all Government departments interested, to contractors and subcontractors, and to the selling producers, or vendors.

During July it was estimated that the Government would require 25,000 tons of pig lead for the months of August, September, and October. The procedure adopted for supplying the July lead having proven entirely acceptable to the Government, a similar proposal for the ensuing three months was made by the committee and agreed to by Mr. Baruch and by the various departments.

In September the price broke sharply below 8 cents, East St. Louis. It was evident that the average September St. Louis price would be in excess of this figure, but also practically certain that the average price for October would be below it. Although the Government had accepted the proposal of the committee to supply 25,000 tons at the 8-cent price for August, September, and October, the committee voluntarily offered to abrogate this arrangement for October, as its members did not desire to charge the Government more than commercial consumers were paying, however much less it had been charged during the preceding months. It was therefore arranged that the 8 cent Government lead purchase should terminate with September shipment lead, and that the Government requirements for October should be allotted at the average "Engineering and Mining Journal" St. Louis price for that month, f. o. b. East St. Louis, the price to be paid being guaranteed not to exceed 8 cents.

Owing to the fact that the food and fuel control bill, which had been passed by Congress, then made it illegal for any persons to act in an advisory capacity to the Government on matters pertaining to an industry in which they were financially interested, the members of the committee were now put in an anomalous position. Although their activities had resulted in not only a great saving to the Government in obtaining lead for it below the market, but also in the simplification of the distribution and purchasing problems of the various Washington departments, many of which were at that time more or less in embryo, no legal alternative was left the committee but to disband. It accordingly went out of existence on October 31, 1917.

After the committee on lead disbanded, Irwin H. Cornell, the former secretary of the committee, at the request of Eugene L. Meyer, jr., of the committee on raw materials, minerals, and metals, of the Council of National Defense, acted as the representative of the lead producers in allotting Government orders and in cooperating, as before, with the Government, but informal meetings of the producers were held at intervals to consult regarding the work. Recognizing the advantages of a definite and continuous price arrangement, Mr. Meyer reached an agreement with the producers to reserve the Government requirements of lead from December, 1917, to March, 1918, inclusive, at the average St. Louis price of lead for the month of reservation. At the expiration of this agreement, one practically identical was made for April to July, 1918, inclusive, and later for August to November, inclusive.

In June, 1918, the lead producers' committee for war service was formed at the request of Mr. Baruch and consisted of

Clinton H. Crane, chairman, St. Joseph Lead Co.
Edward Brush, American Smelting & Refining Co.
Harry L. Day, Pennsylvania Smelting Co.
A. W. Dodd, American Zinc, Lead & Smelting Co.
Julius Loeb, American Metal Co.
F. Y. Robertson, U. S. Smelting, Refining & Mining Co.
L. Vogelstein, L. Vogelstein & Co.
T. Wolfson, United Metals Selling Co.
Arthur K. Mitchell, secretary.

The secretary continued to allot Government business for June, which work had been started during the régime of Mr. Cornell. At about this time the Government requirements began to be progressively greater, and the need for additional lead developed so rapidly that it became increasingly difficult to accurately estimate the tonnage needed for each month by the 15th of the one preceding. For May, for example, 6,000 tons had been originally reserved, although the Government allotments ultimately amounted to 10,235 tons, the balance being furnished by canvass among the producers. In June, also, the original reserve of 9,500 tons, announced on May 15, was increased to 12,011½ tons, the increment being contributed by three members of the committee in spite of the rising market.

The price had been steadily increasing since early in 1918 and had reached 7.25 cents, New York, by the middle of June. In spite of concerted and successful efforts to stimulate production, it was evident that a larger and larger proportion of the lead supply was being diverted for direct or indirect war work. The so-called Government lead purchases only represented a fraction of the war use of the metal. Many contracts were let by various Government bureaus on a fixed-price basis involving the commercial purchase by the contractor of the lead required. Indirect war uses of manufactured lead products also augmented the demand for the metal to such an extent that it was certain that a high market price would result were no effort made to control it. The Government had long since initiated its policy of price-fixing on important war materials. The lead producers, however, had controlled their own industry from the start, entirely to the satisfaction of the chairman of the War Industries Board. Therefore, rather than have the price fixing committee of the board set an official maximum price, the lead producers' committee, through Mr. Crane, voluntarily offered to limit the price to $7.75 per 100 pounds, East St. Louis basis. Mr. Baruch and Mr. Yeatman agreed to this arrangement, which became effective on June 17, 1918.

Producers not represented on the committee were acquainted with the agreement which had been made, and all consented to adhere to it. Standard differentials to be used in determining prices for all destinations were established and future contracts were made as well as existing contracts modified in conformity therewith. It was decided that no domestic lead should be exported without the committee's consent and that none whatsoever should be furnished for resale, thus obviating the possibility of advantage being taken by speculators of the price regulation. As July advanced the scarcity of lead became continually more pronounced, and an increasing number of essential war manufacturers, who had not previously arranged for the supply of their requirements, found difficulty in doing so in the market. The July Government lead purchase was 12,999½ tons, approximately 1,000 tons in excess of the maximum figure in the proposal of the producers to the Government.

Until the summer of 1918, with the exception of certain small shipments arranged for the Government for export overseas, the committee had taken no jurisdiction whatsoever over bonded lead, the majority of which had been purchased under contract by Great Britain, although a considerable tonnage had been going to the Orient. In August, however, Mr. Yeatman requested the committee to endeavor to arrange that the maximum amount possible of bonded lead be reserved for England. To do so it became necessary to refuse to accept further orders for shipment to China and Japan. At this time also a complete stop was put on exports of domestic lead.

The stringency continually became more acute and all producers were urged to discriminate in selling their output against purchasers who were not engaged in essential war work. Although no lead was offered to wholesale brokers, nevertheless, it was impossible, without injustice, to refuse to indirectly supply retail users, and it was decided to sell to bona fide jobbers when they agreed to resell only to such retail consumers as in their judgment were essential and in no case to quote more than 50 cents per 100 pounds (ex-warehouse) in excess of the ruling wholesale price.

Everything possible was done under the existing conditions to conserve the available supply and to divert the maximum feasible amount for essential war purposes. It was estimated that at least 80 per cent of the domestic production was thus used. Nevertheless, as long as a consumer could buy lead from two or more independent sources, no check could be had on the total quantity thus obtained, and certain essential users were very likely to suffer in consequence.

On September 4, consequently, at the desire of Mr. Yeatman, the committee took over the allocation of all pig lead produced or refined in the United States of either domestic or foreign origin.

In allotting lead to consumers the secretary was guided by the character of the work upon which it was to be applied, invariably giving preference to such uses as were manifestly essential to the war.

Investigation showed that there were comparatively few uses of lead which were not essential in some degree to the prosecution of the war. In discriminating between them, it was therefore not so much a question of determining the nonessential as the less essential uses. Of the latter, the manufacture of shot for trap shooting and general sporting purposes and of white lead for ultimate purely domestic consumption were considered to be the chief. A meeting of all the shot manufacturers was called by Mr. Crane in September, and as a result each agreed to accept for commercial work during the balance of the year two-thirds as much lead as he was then using. Curtailment among the corroders was partly effected through the White Lead Institute, and the paint and pigment section of the War Industries Board obtained certain substitutions of other pigments for high-grade lead paints then being specified by the Government itself for temporary construction, such as cantonment and freight-car bodies. Generally speaking, the response of the country as a whole to the committee's appeal for the conservation of lead was most patriotic. Orders for nonessential manufactured lead products were generally refused, and campaigns were instituted for the recovery of all lead in scrap and dross, some of which had been lying idle for years. The committee could but appeal for cooperation; it had no official powers to enforce regulations, but the alternative of shutting off the lead supply of recalcitrant consumers had to be seldom exercised.

In October the Government purchase amounted to 11,017 tons, much of it being allotted at the instructions of the Ordnance Department to munition manufacturers at eastern points in order to forestall the possibility of a shortage during the coming winter caused by any freight congestion similar to that of a year before.

The demand for commercial lead became more acute, partly due to the natural desire of all manufacturers in the East to stock up for the winter. Sufficient to allow them more than one month's supply, however, was not available, although the production during October was over 52,000 tons, the largest since September, 1917. To anticipate a possibly even greater stringency, the committee requested and received from every consumer and dealer a statement of total pig-lead purchases during each of the years 1915, 1916, and 1917, so that in the event it became necessary to systematically ration the country, after the Government and manufacturers having priority committee classification had been supplied, this could be done intelligently and equitably, according to nature of use and previous normal consumption. At this time also affidavits were requested of some consumers regarding their classification under the priority ruling then in effect.

The amount of the November Government reserve was set on October 15, by Mr. Yeatman at 12,000 tons. By the first few days in November the majority of this had been allotted, together with a large tonnage of commercial lead, but after the signing of the armistice on November 11 conditions rapidly changed. Comparatively few applications for lead were received, and authorizations for allotments from the Government practically ceased. Although contracts had been signed for nearly all of the 12,000 tons of November Government lead, the producers nevertheless again offered to forego their profits, this time by canceling at the request of the Government any orders for lead that remained unshipped.

Whereas with a demand considerably greater than the available supply the policy of selling all lead at a fixed price had proven entirely practicable, with the signing of the armistice and the consequent tremendously decreased demand, it became evident that a future policy for the control of the output should be immediately decided upon by the producers, if a free market were not to be at once declared. To make the transition as gradual as possible, Mr. Baruch requested Mr. Crane to continue the committee until the 1st of the following January, when it went out of existence.

UNITED STATES WAR INDUSTRIES BOARD.

The nonferrous metals section of the War Industries Board, from its inception, bore a vital relation to the war-metal industries. The operations of the section are briefly described in a report from which the paragraphs relating to lead are given below.[2]

ORGANIZATION.

The nonferrous metal section was organized in October, 1917, with Mr. Eugene M. Meyer, jr., as section chief. He was assisted by Messrs. O. F. Weber, H. G. Moulton, and E. M. Friedman, and later by Mr. Pope Yeatman. In March, 1918, Mr. Meyer transferred his activities to a directorship in the War Finance Corporation, and Mr. Yeatman was made section chief. In October, 1918, Mr. Yeatman's title was changed to "Director," and the personnel under him has included E. Coppee Thurston, assistant; Irwin H. Cornell, in charge of lead; George C. Stone, in charge of zinc; Andrew Walz, assistant; and Lieut. H. R. Aldrich, statistician.

The metals handled by this section under Mr. Yeatman are aluminum, antimony, copper, lead, nickel, quicksilver, and zinc. The duty of this section has been to ascertain the requirements of the American and Allied Governments and the essential commercial needs of the country in these raw materials and when necessary to encourage an increase in their production. It has been the aim to interfere as little as possible with the normal course of business and to have the producers, importers, dealers, and consumers feel that it was the section's desire to understand and help them in their difficulties, and it is pleasant to record the almost universal and hearty spirit of cooperation in the industries.

PRODUCTION.

The increase in demand for lead on account of the war was less than for most of the other metals and was taken care of mainly by restricting the use of lead for less essential purposes.

CAUSES OF SHORTAGE.

The shortage in lead which developed toward the end of August, 1918, was not due to any one specific cause but to a combination of labor troubles, transportation difficulties, lack of smelting capacity, and temporarily increased demands.

EMBARGOES.

Export embargoes.—All of the metals handled by this section, except zinc, were on the War Trade Board's export conservation list, for which individual licenses were required for shipment. All these restrictions have now been removed.

Import embargoes.—The import of lead bullion by water was embargoed, but the embargo has been raised, and lead bullion may now come in freely.

PRICES.

Government prices before price fixing.—In the summer of 1917, when the price was over 11 cents, the producers offered to supply the Government's requirements for August, September, and October, estimated at 25,000 tons, at 8 cents flat East St. Louis. This was done until toward the end of September, 1917, when the market price fell below that figure.

Price arrangements made outside the price-fixing committee.—Though it has been the Government's desire to interfere as little as possible with the industries, it was sometimes found necessary to advise that prices must be kept below excessive figures, only sufficiently high to produce an adequate supply to meet the Government's needs without overproduction, the alternative being a consideration of the conditions and the fixing of a price by the price-fixing committee. This was so in the case of lead, which was never considered by the price-fixing committee and for which the price never rose above 7.75 cents per pound East St. Louis or 8.05 cents per pound New York.

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[2] Report on the activities of the nonferrous section, United States War Industries Board, Dec. 31, 1918.

Present trend of prices.—The price of lead was never fixed by the board, but for some months remained constant at 7.75 cents per pound St. Louis until December 2, 1918, when it dropped 1 cent per pound. The market is at present weak, and the tendency is downward.

METHODS OF CONTROL.

The lead producers' committee for war service, with offices at 61 Broadway, New York, have in a similar manner controlled the distribution of domestic lead, subject to this section's supervision and since August, 1918, they have handled bonded lead also. No applications for priority were required for this commodity.

METHODS OF PURCHASE.

Government purchasing departments entered into four-month agreements with the various lead producers by arrangement between this section and the lead producers' committee for war service. This agreement provided for monthly maximum and minimum quantities, and on the 15th of each month the lead producers' committee was informed through this section of the approximate amounts required by each Government purchasing department for the ensuing month. The last four-month agreement expired November 30, 1918, and was not renewed.

WAR EXPORTS.

The following tables bring together the quantity and value of the exports of pig lead and manufactures of lead for the period of the war. As these tables have been published in this form only during the war they are given here to round out the foregoing account of the relations of the war to the lead industry. For the greater part they are not duplicated elsewhere in this chapter.

Lead exported from the United States, 1914–1918, by classes.

Material.	1914		1915		1916		1917		1918	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
From domestic ore:										
Lead, pigs or bars	117,443,900	$4,501,674	176,612,208	$7,928,518	200,999,835	$13,494,065	107,376,638	$9,560,598	83,662,322	$5,889,381
Lead manufactures	....	1,018,234	....	2,134,834	....	2,522,416	....	2,287,305	....	1,824,126
From foreign ore:										
Lead, pigs and bars	43,090,375	1,536,797	77,236,303	2,738,263	19,760,086	1,111,653	75,304,480	6,650,157	118,832,344	8,309,798
Lead manufactures	....	2,242	....	40,112	....	541	....	900	....	4,347
Lead used in articles exported with benefit of drawback	18,977,352	733,000	7,966,372	353,235	10,341,075	689,043	15,074,947	1,296,445	6,852,173	350,851
	....	7,791,947	....	13,194,962	....	17,817,718	....	19,795,405	....	16,378,503

Pig lead exported from the United States, 1914–1918, by destination, in short tons.

Destination.	1914		1915		1916		1917		1918	
	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.
Canada	4,082	28	20,089	4,275	37,095	983	24,103	10,189	5,590	10,230
Great Britain	24,148	10,233	31,192	20,031	8,048	2,277	13,330	13,461	26,185	40,412
Netherlands	6,739	1,620	945	2,507	2,553	611	140	168	....	....
Belgium	2,661	746	....	....	....	....	....	....	....	....
France	....	560	9,272	2,515	673	174	791	995	11	862
Italy	589	71	2,009	2,591	336	....	731	1,210	1,462	112
Germany	7,382	1,681	....	....	....	....	....	....	....	....
Russia	6,711	5,717	13,524	3,869	17,960	1,285	7,366	7,790	299	115
Japan	2,247	....	3,420	560	14,879	1,765	937	280	4,381	4,319
Other countries	4,163	889	7,855	2,270	18,956	2,785	6,290	3,559	3,903	3,366
	58,722	21,545	88,306	38,618	100,500	9,880	53,688	37,652	41,831	59,416

Lead exported from the United States, by months, 1914–1918, in short tons.

Month.	1914		1915		1916		1917		1918	
	Pigs and bars.		Pigs and bars.		Pigs and bars.		Pigs and bars.		Pigs and bars.	
	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.
January	....	1,363	6,460	3,072	7,192	1,236	8,095	641	4,506	3,321
February	....	166	3,820	1,778	10,246	1,229	3,131	133	5,218	5,100
March	5,838	246	7,023	2,301	8,585	734	3,744	959	8,182	1,083
April	5,931	3,663	19,936	5,133	5,870	582	3,454	2,382	6,256	1,502
May	2,045	2,420	15,312	3,021	7,558	640	4,197	1,209	6,977	2,765
June	6,348	976	5,401	1,913	7,167	322	3,333	4,017	2,645	8,265
July	10,894	1,119	1,408	3,162	9,009	1,560	3,135	373	3,001	5,378
August	5,486	....	979	5,233	7,542	548	1,899	94	1,539	7,992
September	2,793	923	2,458	3,723	15,633	722	4,346	798	1,666	7,601
October	7,829	2,521	7,209	3,284	9,486	776	2,665	10,519	51	4,128
November	8,417	5,297	9,886	315	6,402	610	7,344	1,105	706	7,603
December	3,141	2,851	8,354	5,683	5,810	921	8,345	15,422	1,084	4,678
	58,722	21,545	88,306	38,618	100,500	9,880	53,688	37,652	41,831	59,416
Foreign lead used in articles exported with benefit of drawback	....	9,489	....	3,983	....	5,171	....	7,537	....	3,426

The chart (fig. 17) shows graphically, for the period of the war, the total production of lead (including that in by-product antimonial lead but excluding that recovered in pigments smelted directly from ore), the exports of foreign and domestic lead, the consumption in white lead and lead oxides as well as the consumption in metallic form and in antimonial lead. The domestic consumption expanded in 1917–18, but lead sent abroad for the use of the American Expeditionary Forces is not regarded as exported, and this accounts in part for the expansion.

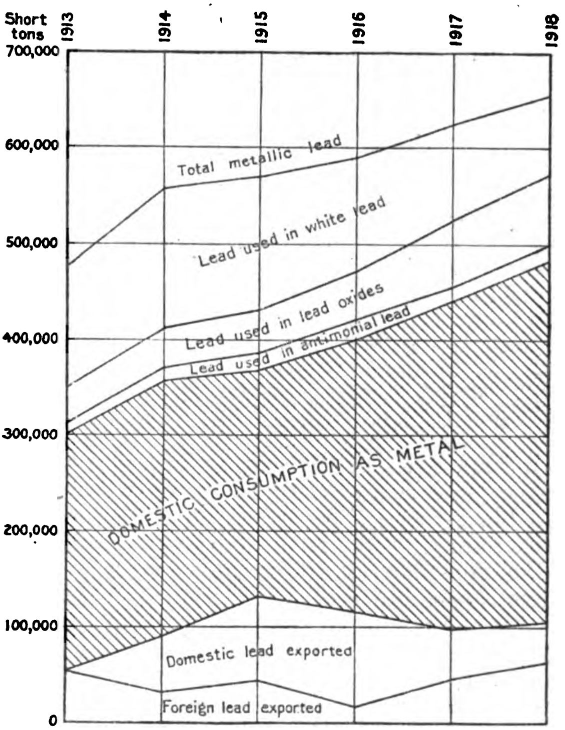


FIGURE 17.—Lead produced, exported, and consumed by the United States, 1913–1918.

TRADE CONDITIONS.

WORLD'S PRODUCTION.

World's production of lead by countries where smelted but not necessarily refined, 1913–1918.

[Reduced where necessary to metric tons.]

Country.	1913 [a]	1913	1914	1915	1916	1917	1918
Australia	116,000	**110,444**	**101,788**	**102,721**	**134,072**	**144,950**	**163,398**
Africa (Rhodesia)	....	331	**152**	**23**	....	**5,632**	**9,398**
Austria-Hungary	24,100	1,368	755	....	....	....	....
Belgium	50,800	**103,480**	**70,980**	**16,770**	**15,560**	**22,745**	**29,630**
Canada	17,100	**17,992**	**16,531**	**19,739**	**19,550**	**18,791**	**16,254**
France	28,000	**28,817**	**29,601**	**14,539**	**24,276**	**21,235**	**12,7.8**
Germany	181,100	....	....	....	....	....	....
Great Britain	30,500	30,990	20,000	16,020	12,980	11,614	....
Greece	18,400	**18,309**	**20,684**	**11,505**	**9,424**	**1,422**	....
India (Burma)	....	**5,951**	10,717	**13,738**	**14,011**	**17,233**	**19,379**
Italy	21,700	**21,674**	**20,464**	**21,812**	**24,362**	**16,237**	**18,322**
Japan	3,600	3,807	4,599	4,793	11,462	15,934	10,769
Mexico [b]	62,000	41,569	14,853	38,319	13,232	50,212	69,035
Norway	....	....	....	....	....	....	....
Russia	1,000	**1,523**	**1,080**	**935**	**540**	....	....
South America	....	93	....	249	137	171	35
Spain	203,000	**198,829**	**143,524**	**171,473**	**147,407**	**176,309**	**169,789**
Sweden	1,500	**1,235**	**1,396**	**1,917**	**2,076**	**3,174**	**2,241**
Turkey	13,900	....	....	....	....	....	....
United States	407,800	**385,643**	**472,126**	**458,656**	**506,490**	**511,942**	**503,762**
Other countries	6,200	....	....	....	....	....	....
	1,186,700	....	....	....	....	....	....

[a] Statistics of the Metallgesellschaft for 1913, given for comparison.

[b] In the absence of any official Mexican reports of smelter output of lead, or of exports, the imports of Mexican lead into the United States in the form of pig lead and bullion are given.

The foregoing statistics of the world's production of lead, though incomplete, give some idea of the foreign production during the war. The figures in black-faced type are taken from the official statistics of the countries named; those in ordinary type are taken from statistical handbooks, consular reports, market letters, and trade journals. There is always a possibility of duplication in figures showing world production, for some countries send "work lead" or base bullion to other countries for refining. Furthermore, secondary and antimonial lead are included in the figures showing the foreign production, so that to put the United States on an equal footing in the statistics it would be necessary to include in its production the domestic output of secondary lead and antimonial lead. The figures for the United States represent refined lead that was smelted in this country, whatever the source of the ore.

IMPORTS AND EXPORTS.

WAREHOUSE TRANSACTIONS.

Lead imported into the United States as metal or in ore may be entered for immediate consumption, the duty being paid and the lead going direct to the consumer; or it may be entered for warehouse, bond being given for double the amount of the estimated duty. In the accompanying tables the phrase "general imports" indicates the total imports, including both lead entered for immediate consumption and lead entered for warehouse. From warehouse the lead may be withdrawn for consumption by payment of duty, or it may remain in bond for smelting and refining, finally being either withdrawn for consumption or exported from warehouse with cancellation of bond. The lead entered for immediate consumption and that withdrawn from warehouse for consumption make up the "imports for consumption," which are expressed in the same terms as those under which they were imported. The lead imported for consumption may be actually used in this country, or it may be manufactured into articles which are exported; in the latter event the manufacturer is entitled to the benefit of a drawback of 99 per cent of the duties paid. In the table on page 969, showing foreign lead exported in manufactures with benefit of drawback, the lead is shown in the form in which it was originally imported. On account of diversity of form it is not feasible to show the articles exported with benefit of drawback. The foreign lead given in the table as exported from warehouse is likewise shown in the form in which it was imported and entered for warehouse. Foreign lead exported from warehouse has, since July 1, 1915, been included by the Bureau of Foreign and Domestic Commerce in the domestic exports as "from foreign ore."

The items foreign lead exported from warehouse, domestic exports of lead "from foreign ore," and foreign lead exported in manufactures with benefit of drawback make up the total foreign lead going out of the country. Lead in warehouse and deductions by liquidation being disregarded, the difference between the sum of these exports of foreign lead and the total imports of lead constitutes the foreign lead consumed in this country. For the sake of simplicity this foreign lead is carried on the bonded customs warehouse records in the form in which the lead was entered until the bond is canceled. It must be clearly understood, therefore, that the lead listed in the table of foreign exports of lead, on a later page, was not exported as lead content of ore and base bullion but as refined lead smelted and refined from them. Since 1914, however, all foreign lead exported has been classed as lead, "pigs and bars," except a portion of the articles manufactured from foreign lead and exported with benefit of drawback. For articles not made wholly of lead it would be useless to give weights, but each shipment on which drawback is claimed is accompanied by a manifest of the imported lead used in making the articles and the duty paid thereon. From these manifests is derived the statement of the total quantity of foreign lead used in manufactures exported with the benefit of drawback. For this reason the lead is given in the form in which it was imported.

The following table is taken from the reports of the Bureau of Foreign and Domestic Commerce. For the reasons given above, the lead is shown in the terms in which it was imported. For instance, a considerable part of the lead stated as remaining in ore and base bullion doubtless represents refined lead waiting at the bonded refinery for a favorable market for shipment. If this is borne in mind, the table gives a fair idea of the fluctuations of foreign stock at different times and in different localities.

Lead remaining in warehouse in the United States, Dec. 31, 1910–1918, in pounds.

Year.	Form in which lead was entered for warehouse.		Remaining at—					
	Lead in ore and base bullion.	Pigs, bars, and old.	New York.		Chicago, Ill.	El Paso, Tex.	St. Louis, Mo. [a]	San Francisco, Cal.
			Newark, N. J.	Perth Amboy, N. J.				
1910......	71,794,443	149,082	7,548,936	36,112,136	21,090,631	6,937,667	....	....
1911......	8,869,713	93,082	2,777,692	2,308,322	954,884	2,555,733	273,082	....
1912......	20,891,182	93,802	1,880,828	17,666,768	484,671	767,533	91,382	....
1913......	10,620,953	....	8,785,551		80,880	1,683,091	71,431	....
1914......	15,333,064	3,837	10,309,592		94,775	4,802,961	125,736	....
1915......	24,338,933	....	8,401,728		165,257	14,678,809	104,922	968,217
1916......	23,667,358	1,070,298	8,575,115		4,732,535	6,814,844	3,286,189	256,675
1917......	47,853,945	5,370,445	19,015,511		4,757,315	18,951,649	2,306,855	2,822,615
1918......	33,997,822	944,483	(b)		(b)	(b)	(b)	(b)

[a] Kansas City before 1914.

[b] Not available.

IMPORTS.

The following tables are taken from the reports and records of the Bureau of Foreign and Domestic Commerce:

Lead imported and entered for consumption in the United States, 1910–1918.

Year.	Lead in ore.		Base bullion.		Pigs, bars, and old.		Sheets, pipe, and shot.		Not otherwise specified.	Total value.
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.		
1910..	7,998,859	$198,196	16,543,167	$337,223	6,776,066	$212,858	39,779	$1,972	$4,843	$755,092
1911..	1,474,254	26,563	17,376,459	352,595	7,112,749	242,423	63,151	2,855	7,218	631,654
1912..	935,861	24,760	22,729,467	462,559	5,191,823	110,459	31,184	2,305	5,468	605,551
1913..	2,306,972	75,835	17,665,227	388,116	4,621,270	105,738	39,171	3,291	12,710	585,690
1914..	5,459,961	188,749	8,904,649	301,195	575,290	12,281	62,552	2,753	81,894	586,872
1915..	2,865,792	96,010	15,496,230	519,355	997,368	32,951	201,510	17,059	107,580	772,965
1916..	10,125,983	368,824	5,242,171	208,277	6,388,097	231,235	532	63	106,560	1,014,959
1917..	5,438,931	207,370	6,965,849	470,539	1,756,223	85,743	12,538	2,699	10,287	776,638
1918..	6,064,902	344,080	3,559,071	180,070	1,139,950	56,694	6,892	624	36,723	618,191

Type metal imported and entered for consumption in the United States, 1910–1918.

Year.	Type metal.		Lead content.	
	Gross weight (pounds).	Value.	Quantity (pounds).	Percentage.
1910..........	13,394,199	$485,493	11,176,830	84.9
1911..........	8,390,470	310,658	6,936,711	82.7
1912..........	581,411	18,668	477,006	82.0
1913..........	567,004	20,098	467,688	82.5
1914..........	1,509,538	45,373	1,322,188	87.6
1915..........	2,768,261	107,607	2,424,306	87.6
1916..........	1,162,386	83,816	923,473	79.4
1917..........	....	....	....	....
1918..........	551,794	35,938	513,166	93.0
Average lead content, 1910–1918..........	....	....	....	83.8

General imports of lead into the United States, in ore, base bullion, and refined, 1910–1918, by sources, in pounds.

Year.	Canada.	Mexico.	South America.	Europe.	Other countries.	Total imports.
1910	206,979	203,290,307	6,598,263	2,714,796	4,394,421	217,204,766
1911	270,947	172,633,479	4,778,221	569,161	1,651,544	179,903,352
1912	319,497	159,455,664	3,207,936	829,139	3,309,356	167,121,592
1913	338,569	95,693,439	8,766,327	810,019	8,685,612	114,293,966
1914	384,007	46,282,207	2,417,744	4,898,552	2,694,293	56,676,803
1915	2,303,170	94,247,384	5,420,567	217,773	802,516	102,991,410
1916	12,606,216	48,395,670	6,235,758	575,759	2,845,949	70,659,352
1917	11,738,379	125,782,759	4,556,460	8,945,899	5,520,323	156,543,820
1918	28,225,878	162,259,199	1,962,124	62,510	4,705,049	197,214,760

General imports of lead into the United States, 1910–1918, by classes, in pounds.

Year.	Lead in ore (lead content).	Base bullion.		Pigs, bars, sheets, and old.	Total lead content.
		Gross weight.	Lead content.		
1910	94,751,054	118,061,415	115,483,542	6,970,170	217,204,766
1911	35,686,180	141,481,852	138,952,372	5,264,800	179,903,352
1912	19,577,499	152,420,624	146,999,168	544,925	167,121,592
1913	19,883,313	96,908,170	94,327,654	82,999	114,293,966
1914	23,649,637	33,444,503	32,730,320	296,846	56,676,803
1915	18,185,140	86,247,995	83,986,988	819,282	102,991,410
1916	35,086,100	24,943,660	24,262,435	11,310,817	70,659,352
1917	41,292,876	109,279,997	103,664,970	11,585,974	156,543,820
1918	37,070,340	155,810,003	149,663,889	10,480,531	197,214,760

Basic carbonate (corroded) white lead, red lead, litharge, and orange mineral, imported and entered for consumption in the United States, 1911–1918.

Year.	Corroded white lead.		Red lead.		Litharge.		Orange mineral.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
1911	741,071	$46,213	1,063,533	$42,471	24,662	$1,196	504,734	$28,515
1912	687,705	46,494	757,908	33,854	32,443	1,550	334,551	20,914
1913	672,109	45,266	99,832	4,903	84,023	1,750	330,525	22,205
1914	596,567	40,203	12,554	2,934	33,651	1,805	240,388	16,388
1915	339,157	24,608	1,968	132	20,650	1,422	171,572	14,061
1916	88,617	8,050	20,467	5,302	1,320	150	70,934	8,281
1917	20,238	1,965	50	13	....	....	83,294	4,892
1918	508	202	5	1	100	12	....	....

EXPORTS.

DOMESTIC EXPORTS.

The average difference between the prices of lead at New York and at London for the 10 years prior to 1914 was not far from 1½ cents a pound and the price at New York was the higher. This being the case, exports of domestic pig lead should be expected only under temporary or very unusual circumstances. The practice of the Bureau of Foreign and Domestic Commerce has been to class all exports of lead articles manufactured in this country as domestic exports, whether the lead is of domestic or foreign origin. For this reason no table of exports of domestic lead manufactures has been given, because such a table would duplicate the table showing foreign lead in manufactures exported with benefit of drawback. Since the exports of domestic pig lead began, however, they have been shown separately.

In 1914 the price of lead at London rose above the price at New York early in January and remained between one-fourth and one-half cent a pound above throughout the year. This made it possible to export domestic lead at a profit, and the decrease in imports of lead ore and bullion from Mexico rendered it necessary to satisfy the foreign demand with domestic lead, the exports of which assumed large proportions. The movement commenced in March, 1914, and by the end of the year had reached large proportions. Likewise in 1915 the price of lead at London was from one-fourth to 1 cent a pound higher than the price at New York, except for the period of high prices in the United States during June and July, and exports of domestic lead continued heavy throughtout the year.

Exports of refined lead from domestic ores reached the maximum both as to quantity and value in 1916. They dropped off almost one-half in 1917 and showed a further decline in 1918.

Refined lead made from domestic ores exported from the United States, 1914–1918.

Year.	Quantity (short tons).	Value.
1914	58,722	$4,501,674
1915	88,306	7,928,518
1916	100,500	13,494,065
1917	53,688	9,560,598
1918	41,831	5,889,381

White lead exported from the United States, 1913–1918.

Year.	Quantity (pounds).	Value.
1913	15,062,384	$905,396
1914	17,645,538	1,017,376
1915	25,310,369	1,409,622
1916	27,435,054	2,137,072
1917	19,737,399	2,089,659
1918	15,588,916	1,756,739

FOREIGN EXPORTS.

By foreign lead exports are meant the exports of lead of foreign origin which has been smelted, refined, or manufactured in this country and then shipped abroad. The following table, made up from the records of the Bureau of Foreign and Domestic Commerce, shows the total lead exported for a period of years; but it must be borne in mind, as pointed out on a previous page, that prior to 1915 the actual exports were not in the form shown in the table, which is the import form, but instead consisted of refined lead and lead manufactures. Since July 1, 1915, the exports of foreign lead heretofore classed as "ore," "base bullion," and "pigs, bars, and old" are all included in "pigs, bars, and old" as domestic manufactures of lead from foreign ore. The quantities given for lead exported from warehouse are exact, but the quantities given for lead in manufactures are subject to the waste in manufacturing.

Foreign lead exported from the United States, 1910–1918.

Year.	Exported from warehouse.							Exported in manufactures with benefit of drawback.	
	Lead content of ore.		Lead content of base bullion.		Pigs, bars, and old.		All other manufactures.	Lead content of ore.	Pigs, bars, bullion, and old.
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Value.	Quantity (pounds).	Quantity (pounds).
1910	22,508,090	$248,220	117,045,333	$2,262,057	19,507	$703	$870	6,592,294	11,008,604
1911	39,276,820	730,247	151,986,265	3,093,290	12,311,102	244,037	1,504	674,621	23,485,929
1912	12,796,703	219,859	116,907,305	2,478,256	107,170	3,826	2,121	150,617	22,584,221
1913	11,721,714	271,985	77,253,891	1,827,538	111,506	4,851	3,422	74,628	19,484,345
1914	6,724,525	245,205	10,944,350	378,286	25,421,500	913,306	2,242	4,040,924	14,963,428
1915	(a)	....	(a)	....	77,236,303	2,738,263	40,112	7,966,372	
1916	(a)	....	(a)	....	19,760,086	1,111,653	541	10,341,075	
1917	(a)	....	(a)	....	75,304,480	6,650,157	900	15,074,947	
1918	(a)	....	(a)	....	118,832,344	8,309,798	4,347	6,852,173	

[a] Since July 1, 1915, the Bureau of Foreign and Domestic Commerce has classed all foreign lead exported as "domestic exports, of pigs, bars, etc., produced from foreign."

CONSUMPTION.

APPARENT CONSUMPTION OF REFINED PRIMARY LEAD.

In statements of consumption of lead in these reports prior to 1907 it was the custom to take into account the smelter stocks of lead at the beginning and at the end of the year. It is not to be denied that for the individual year this gives closer figures. It is just as true that account of trade stocks should also be taken to arrive at accurate results; but this is manifestly outside the scope of the work of this Survey. It was found impossible to obtain a complete statement of stocks after 1906; hence consumption was calculated without reference to domestic stocks. At that time a very considerable part, from one-fourth to one-fifth, of the lead smelted and refined in this country was lead of foreign origin smelted in bond, and it is possible to obtain statistics of the stocks of this part, for they are reported annually by the Bureau of Foreign and Domestic Commerce as "merchandise remaining in warehouse at close of year." For the years 1907 to 1917, inclusive, therefore, "lead available for consumption" was calculated by taking the production from domestic ores and using the total imports and exports of foreign lead in all forms—ore, bullion, and pigs—and likewise the stocks of foreign lead in warehouse at the beginning and end of each year. Though complete statements of stocks of refined lead are still unavailable, the conclusion has been reached that a better idea of consumption may be had by basing the calculation, as was done prior to 1907, on the total production of both domestic and foreign lead and on the transactions in refined lead, disregarding altogether the refinery stocks. The "apparent consumption" calculated in this way is given in the table below for the years of the war, together with the average for the four years just prior to the war.

Apparent consumption of refined primary lead in the United States, refinery stocks disregarded, in short tons.

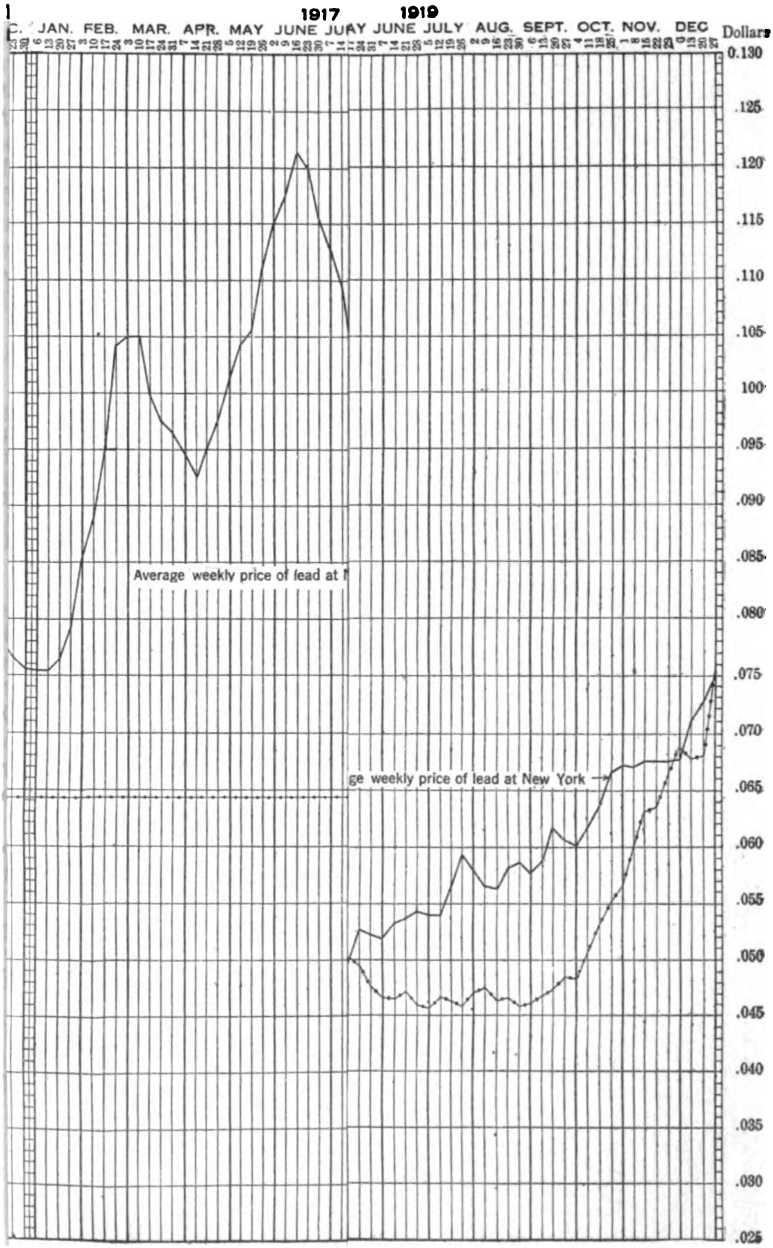
	1910-1913 average.	1914	1915	1916	1917	1918
Supply:						
Stock in bonded warehouses, Jan. 1	79	....	2	....	535	2,685
Imports of pigs, bars, and old	1,608	148	410	5,655	5,793	5,240
Production	475,151	542,122	550,055	571,134	610,769	640,195
	476,838	542,270	550,467	576,789	617,097	648,120
Withdrawn:						
Exports of foreign lead—						
From warehouse	70,256	21,545	38,618	9,880	37,652	59,416
In manufactures, with benefit of drawback	10,505	9,489	3,983	5,171	7,537	3,426
Exports of domestic lead	....	58,722	88,306	100,500	53,688	41,831
Stock in bonded warehouses, Dec. 31	....	2	....	535	2,685	472
	80,761	89,758	130,907	116,086	101,562	105,145
Apparent consumption	396,077	452,512	419,560	460,703	515,535	542,975

CONSUMPTION BY USES.

The shortage of lead which compelled its rationing to consumers, as set forth in the preceding pages, necessitated a canvass of the consumption to ascertain the normal needs of consumers. This canvass was made by the United States War Industries Board for the year 1917, and the first 10 months of 1918, the canvass lapsing with the signing of the armistice. Though these figures of consumption represent war-time uses and not the normal use, they are nevertheless interesting and in much greater detail than any such figures heretofore published.

Lead consumed in the United States, 1917–18, by uses.

	1917		January-October, 1918.	
	Quantity (short tons).	Percentage of production.	Quantity (short tons).	Percentage of production.
As blue lead:				
Lead-incased cable	74,860	12.22	39,239	7.29
Lead pipe, etc	37,434	6.11	29,189	5.42
Sheet lead	31,502	5.14	35,304	6.56
Pig lead retailed in less than carload lots	29,453	4.80	22,098	4.10
Batteries, etc	24,529	4.00	20,986	3.90
Lead foil	21,063	3.43	17,472	3.25
Other white metals	18,071	2.95	14,024	2.60
Shrapnel	15,927	2.60	28,907	5.37
Babbitt	14,661	2.39	13,957	2.59
Solder	13,937	2.28	12,762	2.37
Other bearing metals	11,624	1.90	10,860	2.02
Shot	10,837	1.77	7,424	1.38
Military small arms	8,926	1.46	16,681	3.10
Other sporting ammunition	8,532	1.39	7,680	1.43
Calking lead	5,999	.98	5,588	1.04
Type metals	5,062	.83	3,522	.66
Car seals	890	.15	2,138	.40
Brasses	819	.13	661	.12
Brass castings	717	.12	186	....
Miscellaneous	11,676	1.91	13,096	2.43
	346,519	56.56	301,774	56.03
As oxides:				
White lead in oil	69,483	11.34	60,844	11.30
Dry white lead	22,207	3.63	16,455	3.05
Battery oxides	19,140	3.13	17,432	3.24
Dry red lead and orange mineral	11,769	1.92	14,205	2.64
Glass oxides	6,621	1.08	6,252	1.16
Red lead in oil	1,358	.22	7,488	1.39
Miscellaneous	36,766	6.00	29,127	5.41
	167,344	27.32	151,803	28.19
Total accounted for	513,863	83.88	453,577	84.22
Production	612,609	100.00	538,580	100.00



D AT NEW YORK AND LONDON E 1918—PT. 1. (To face page 970.)

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PRICES AND VALUE.

The price of lead at New York began the year at 6.6 cents a pound and rose to slightly above 7.6 cents during the first week of March. After declining to 7.1 cents in the first part of May it again rose, reaching 8.05 cents July 5. At this point, with lead very scarce and the market on the rise, the lead producers' committee limited the price to 8.05 cents, at which it remained until the signing of the armistice, after which, consequent on the cancellation of contracts and orders for munitions, the price of lead dropped rapidly, closing the year at 5.75 cents a pound. The average price, as figured from the total sales during the year, was 7.1 cents a pound, as compared with 8.6 cents a pound in 1917. These are the figures used in calculating the value of the lead produced from domestic ores in the United States in those years.

The following are the changes in the prices quoted on lead by the American Smelting & Refining Co. in 1918:

	Cents a pound.
January 2	6.25
January 3	6.50
January 11	6.75
February 11	7.00
February 26	7.25
April 11	7.00
June 4	7.25
June 17	7.82½
June 25	7.90
July 3	8.05
December 2	7.05
December 23	6.50
December 27	6.00

The London price of lead fixed by the Government for immediate shipment, which had remained throughout 1917 at £30 10s. a long ton (6.4 cents a pound), was reduced to £29 10s. a long ton (6.3 cents a pound) at the beginning of 1918 and remained at that figure until the signing of the armistice. The price of lead fixed by the British Government had been through most of the war far below the price of lead in the United States and the business in lead had been strictly under control of the British Government. After the armistice was declared the British Government advanced the price of lead to £40 10s. a long ton (8.6 cents a pound) and held it there the remainder of the year. The average price for the year was £30 9s. 3d. a long ton (6.4 cents a pound).

The fluctuations in the price of lead at New York and London are graphically shown in Plate VIII, which gives curves of the average weekly price of lead in those markets for the years 1914 to 1919, inclusive.

As stated on page 937, the value of the output of refined lead in the United States from domestic ores in 1918 was $76,667,000, at the average sales price of refined lead, as compared with $94,333,000, based on the average price in 1917, a loss of $17,666,000, or nearly 19 per cent.

TUNGSTEN.

By **Frank L. Hess.**

PRODUCTION.[1]

The tungsten ore produced in the United States in 1918 was equivalent to 5,061 short tons of concentrates carrying 60 per cent of tungsten trioxide (WO_3), valued at $7,049,300, an average of $23.22 a unit, of which 188 tons, arbitrarily valued at $225,750, was on hand at the end of the year. Although large, the output was less than that of either of the two preceding years, for in 1916 the production was 5,923 tons, valued at $12,074,000, and in 1917 it was 6,144 tons, valued at $6,783,000.

Colorado led with 1,910 short tons of concentrates, all of which was ferberite, against California's 1,791 tons of scheelite and Nevada's 898 tons of concentrates, all but 13 tons of which was scheelite. In 1917 California produced 2,781 tons and Colorado 2,707 tons, but in 1916 Colorado was the leader.

Concentrated tungsten ores (carrying 60 per cent of tungsten trioxide) produced in the United States, 1900–1918.[a]

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1900	46	$11,040	1910	1,821	$832,992
1901	179	27,720	1911	1,139	407,985
1902	184	34,040	1912	1,330	502,158
1903	292	43,639	1913	1,537	672,118
1904	740	184,000	1914	990	435,000
1905	803	268,676	1915	2,332	4,100,000
1906	928	348,867	1916	5,923	12,074,000
1907	1,640	890,048	1917	6,144	6,783,000
1908	671	229,955	1918	5,061	7,049,300
1909	1,619	614,370			

[a] The tungsten content of the ores produced in 1901-1905, inclusive, is unknown but was probably not far from 60 per cent of WO_3 and was likely a little more rather than less.

Concentrated tungsten ores (carrying 60 per cent of tungsten trioxide) produced in the United States, 1916–1918, by States, in short tons.

State.	1916	1917	1918
Alaska	47	32	14
Arizona	218	150	213
California	2,171	2,781	1,791
Colorado	2,401	2,707	1,910
Idaho	101	2	....
Nevada	689	143	898
New Mexico	16	(a)	4
South Dakota	239	270	201
Other States [b]	41	59	30
	5,923	6,144	5,061

[a] Less than 1 ton.

[b] 1916: Connecticut, Missouri, Montana, Oregon, Utah, and Washington; 1917: Montana, Oregon, Utah, and Washington; 1918: Montana, Utah, and Washington.

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[1] Unless otherwise stated, the short ton is used throughout this article.

The ores produced in 1918 consisted of approximately 1,910 tons of ferberite, 55 tons of huebnerite, 2,734 tons of scheelite, and 362 tons of wolframite.

One of the remarkable developments of the year was the large production of scheelite in the Great Basin region from contact-metamorphic deposits—limestones altered by solutions accompanying intrusions of granite. Much the larger part of the ore mined in Nevada, in fact all reported except that from the Tungsten Dyke mine, at Sodaville, and 13 tons of huebnerite was taken from contact-metamorphic deposits. The deposits at Bishop, Calif., also furnished a considerable quantity. Altogether the contact-metamorphic deposits gave an output of 1,427 tons. In the Eugene Mountains, about 7 miles northwest of Mill City, the Nevada Humboldt Tungsten Mining Co. and the Pacific Tungsten Co. erected mills which began work late in the year. A pipe line 22,000 feet long, to bring water from wells in the valley of Humboldt River, two pumping stations to lift the water more than 1,100 feet to the mines, and a power line 32½ miles long to bring electricity to them were built by a mutual subsidiary company, the Mill City Development Co. A tramway 3½ miles long, with a gasoline locomotive and steel cars, hauled the ore of the Mill City Mining Co., a closely related concern, to the Pacific Tungsten Co.'s mill. The mines had gasoline hoists, soon to be replaced by electric hoists.

The expenditures and receipts of the Pacific Tungsten Co. as given by it and rearranged by the auditor of the War Minerals Relief Commission in considering the company's claim for relief from the Government were as follows:

Pacific Tungsten Co.:			
Purchase of properties	$160, 948. 18		
Machinery, plant, and buildings	54, 132. 44		
Railroad construction and equipment	20, 012. 35		
Camp water-supply system	3, 756. 25		
Mine equipment	22, 289. 36		
Mine development	59, 915. 69		
Surface improvements	1, 495. 84		
		$322, 550. 11	
For Mill City Tungsten Mining Co.:			
Purchase of 75 per cent of capital stock	125, 000. 00		
Development and operation	6, 909. 26		
		131, 909. 26	
For Pacific Milling Co.:			
Mill construction and equipment		121, 016. 25	
For Mill City Development Co.:			
Pipe line		15, 291. 88	
For construction of power line		31, 961. 30	
			$622, 728. 80
Operation:			
Milling costs	117, 134. 01		
Milling costs, own mill	23.595. 00		
		140, 729. 01	
Ore extraction		25, 507. 41	
Ore transportation (interplant)		2, 068. 12	
			168, 304. 54
Administration and general expense:			
Legal, preliminary, and corporation		9, 827. 28	
Interest		3, 633. 40	
General expense		24. 453. 16	
Insurance and taxes		3, 631. 09	
			41, 544. 93

On hand in warehouse and commissary	$9,476.45
Bills payable	70,700.78
	912,755.50
Receipts	297,597.42
Deficit	615,158.08

An estimate of the cost of production per ton of ore was presented to the Committee on Finance of the United States Senate, November 11, 1919, by Frank W. Griffin, as below:

Labor	$5.96
Compensatory insurance	.31
Explosives	.30
Timber	.29
Tools	.12
Repairs	.52
Power	.83
Pumping	.51
Transport and tramway	.61
Freight and hauling	.91
Mill supplies	.93
General supplies	1.31
Office expenses	.20
	12.80

Charles T. Van Winkle and Matthew Van Siclen, in a report to the War Minerals Relief Commission, estimated the cost of production per ton of ore in sight thus:

Estimated costs per ton.

Mining and development	$5.00
Transportation, mine to mill	.50
Milling	2.50
General expense	1.35
Freight and miscellaneous	2.00
	11.35

Available ore: 4,229 tons, carrying 2.44 per cent WO_3, 28,484 tons, carrying 1.44 per cent WO_3; total, 32,713 tons, carrying 1.57 per cent WO_3 in place, or 1.44 per cent WO_3 mined, allowing for adulteration by waste, of which 1.1376 per cent WO_3 is recoverable. A price of $10 per unit is therefore the minimum on which the property can clear expenses.

The company shipped 7,032 dry tons of ore to Toulon, 68 miles southwest of its mines, where the ore was concentrated in the mill of the Humboldt County Tungsten Mines & Mills Co. The ore as shipped weighed 7,195 tons. The wagon haul from the mine to Mill City, 9 miles, cost $6 a ton, and the railroad haul $1.75. In addition 5,554 tons of ore was milled in the company's mill during November and December, 1918, and January, 1919, a total of 12,749 tons. From the ore 581,228 pounds of concentrates, carrying 68.45 to 71.62 per cent of WO_3, was made and shipped. Of this quantity 380,667 pounds was sold for $337,067.30 and the remainder, 200,561 pounds, was given as security for a loan. The concentrates contained 20,463 units of WO_3, equal to 70.41 per cent of WO_3, or a yield of 2.28 per cent of WO_3 from the dry ore. Of this quantity 2,408 tons was produced and milled in January, 1919. The ore milled at Toulon yielded 2.71 per cent of WO_3, but leaner ore could be handled for the same cost at the company's own mill, and the yield from the ore milled there was 1.72 per cent of WO_3.

The ore as sampled at Toulon ran from 1.06 to 2.44 per cent of WO_3, as shown by the report of Charles T. Van Winkle to the War Minerals Relief Commission, and the tailings carried from 0.13 to 0.54 per cent of WO_3, giving a recovery of 66 to 94.1 per cent, with an average of about 80 per cent.

At Bishop, Calif., the Standard Tungsten Co., which had been working contact-metamorphic deposits, ran out of ore and after re-treating a part of the tailings closed its mill. The costs of producing concentrate during 1917 and 1918 are given by A. J. Clark, president of the Standard Tungsten Co., as follows:

Schedule of cost, 1917 and 1918, Standard Tungsten Co.

Ore mined……tons		44,000
Scheelite produced……units of WO_3, 20 pounds each		12,544
Average assay [of concentrates]……per cent of WO_3		62
Tons [of concentrates]		202
Costs:		Per unit.
Materials, supplies, power, and repairs	$137,770.06	$10.991
Mine office expense	2,283.69	.182
Miscellaneous	3,159.71	.252
Insurance, fire and life	4,186.84	.334
Taxes	303.13	.024
Interest paid	6,693.10	.533
Marketing product	4,797.36	.382
General office	14,075.00	1.122
	173,268.89	13.82

The Pine Creek Tungsten Co. began active work on the development of a contact-metamorphic deposit about 25 miles northwest of Bishop at an altitude of about 11,000 feet. The altitude is so high that during a large part of the year snow hampers operations that are not carried on under cover. Snows are reported as probable any time after October 1. The country is very rough and steep, and many miles of road had to be constructed. Timber for the mill and other buildings was cut from the surrounding mountains. An electric power line was constructed by the Southern Sierras Power Co. from its line at the Round Valley Tungsten Co.'s mine, 17 miles away. The mine and mill are connected by a 3-rail gravity tramway 2,200 feet long.

Milling began on December 12, 1918, and by February 9, 1919, when the mill was closed, the costs were reported by Cooper Shapley, president of the company, to have been as follows:

Mining and milling costs at the Pine Creek tungsten mine, from Dec. 12, 1918, to Feb. 9, 1919.

[Total number tons milled, 4,371.]

	Total cost.	Cost per ton.		Total cost.	Cost per ton.
Ore breaking	$4,764.39	$1.090	Marketing product (estimate)	$743.07	$0.170
Development	1,792.11	.410	Mess house (loss)	218.55	.049
Tramming	1,639.12	.375	Truck maintenance	240.40	.055
Timbering	174.84	.040	Engineering, maps, plans	388.64	.088
Milling	4,414.71	1.010	General expense [a]	2,666.31	.630
Mill maintenance	1,180.17	.270			
Mine equipment	546.37	.125	Cost of mining and milling 1 ton crude ore		4.817
Surface improvements	1,005.33	.230			
Taxes, insurance	1,005.33	.230			
Water supply	196.69	.045			

[a] General expense includes office, manager's salary, sampling, assaying, fuel, telephone, postage, telegrams, entertainment, and charity.

	Per cent WO_3.
Average assay of ore milled	0.613
Average loss in milling	.216
Recovered WO_3	.397

0.397 per cent WO_3=7.94 pounds WO_3, which cost $4.817; therefore 1 pound cost $0.6067, or for 20 pounds, or 1 unit, the cost is $12.13.

Mr. Shapley was also general manager of the Round Valley Tungsten Co., and for the costs of producing concentrates on that property he gives the following figures:

Mining and milling costs at the Round Valley tungsten mine, 1918.

[Total number of tons milled during 1918, 31,678.]

	Total cost.	Cost per ton.		Total cost.	Cost per ton.
Ore breaking	$22,420.18	$0.708	Water supply	$1,267.12	$0.040
Development	16,556.10	.523	Marketing product	5,385.26	.170
Tramming	5,910.51	.185	Mess-house expense (loss)	1,267.12	.040
Prospecting	875.43	.028	Auto maintenance	1,425.51	.045
Timbering	280.63	.008	Engineering, maps, and plans	2,217.46	.070
Milling	31,200.30	.985	General expense [a]	16,630.95	.525
Mill maintenance	13,929.96	.439			
Mine equipment	3,767.76	.118			
Surface improvements	6,251.88	.197	Cost of mining and milling 1 ton crude ore		4.241
Taxes, insurance	4,679.50	.160			

[a] General expense includes office, manager's salary, sampling, assaying, postage, telegrams, fuel, entertainment, charity, and telephone.

	Per cent WO_3.
Average assay of ore milled	0.395
Average loss in milling	.0936
Recovered WO_3	.301

0.301 per cent WO_3=6.02 pounds WO_3 which cost $4.241; therefore 1 pound costs $0.7043, or for 20 pounds, or 1 unit, the cost is $14.09.

For the costs of the Tungsten Mines Co., also operating near Bishop, Frank W. Griffin, the manager and vice president, gives the following figures:

Production and costs, 1918, Tungsten Mines Co., Bishop, Calif.

Ore milled	tons	71,125
Concentrates produced	tons	337.5
	pounds per ton of ore	9.488
Average WO_3 content of concentrates	per cent	62.044
Units produced		20,930
Mill heads average in WO_3	per cent	0.459
Mill tails average in WO_3	do	.170
Extraction by difference of heads and tails assays, per cent		62.96
Extraction by assay of heads and concentrates produced	per cent	64.14
Time run	hours	6,118
Time lost	do	2,642

The operating and overhead costs were as follows, depreciation and depletion excluded:

Bishop (operating costs):		
Labor	$133,224.54	
Supplies	64,183.58	
Light and power	12,841.90	
Workmen's compensation insurance	6,534.59	
Fire insurance	2,895.52	
Taxes on property	1,691.42	
Property surveys	215.00	
Hospital service	300.00	
Water assessments	112.00	
Traveling expense	1,797.82	
		$223,796.37
San Francisco office (overhead costs):		
Interest paid on notes	7,321.83	
Interest paid on bond issue	18,061.10	
United States tax on bond interest	99.20	
General overhead—salaries, rent, legal, and general expenses of administration	18,205.32	
Office expense, miscellaneous	1,180.27	
		44,867.72
		268,664.09

Average costs as determined at time of sales:	Per ton of ore milled.	Per unit of WO_3.
Operating costs	$3.14	$10.69
Overhead costs	.63	2.14
	3.77	12.83

Production and costs, 1918, Tungsten Mines Co.

	Ore milled (tons).	Concentrates produced per ton of ore (pounds).	Concentrates produced (pounds).	Mine assays (per cent WO_3).	Extractions (per cent).
January	5,843	12.5	73,400	62.15	64.00
February	5,289	14.2	72,300	61.70	62.70
March	5,765	12.5	72,000	63.59	71.00
April	5,418	10.9	59,300	59.11	70.63
May	5,929	10.1	60,300	63.80	64.37
June	5,818	8.8	51,500	60.60	65.90
July	6,356	8.2	52,300	62.60	62.93
August	6,580	6.8	45,100	62.28	58.49
September	5,470	8.8	48,200	63.79	60.43
October	5,500	8.8	48,500	61.70	59.11
November	6,165	7.0	43,300	60.16	61.07
December	6,992	6.9	48,500	61.30	61.09
Total or average	71,125	9.6	674,700	61.90	....

It will be noticed that the mine assays show an average of 0.144 per cent less WO_3 in the concentrates than the figure first given, which is presumably made up from sales.

During the year 843 feet of raises, 439 feet of drifts, and 147 feet of crosscuts, a total of 1,429 feet, were driven; 69,745 short tons of ore and 6,670 tons of waste rock were broken, of which 68,853 tons were broken in glory holes. A little ore was also broken in properties being prospected, and some diamond drilling was done.

Most of the tungsten-bearing rock left in the mine assayed about 0.21 or 0.22 per cent of WO_3, but on the Little Sister claim a drift showed 10 feet of rock carrying 0.43 per cent and on the Jack Rabbit claim a raise passed through 27 feet of rock carrying 0.5 per cent.

The oldest mine working the contact-metamorphic deposits, the St. Anthony, 20 miles southwest of Lovelock, Nev., was operated by lessees and yielded about 32 tons of concentrates. A promising ore body carrying a little more than 1 per cent of WO_3 was also opened. The Ranson claims, on the east side of the Nightingale Mountains, were prospected, and ore much better than the average is said to have been taken out. Heavy bodies of iron sulphides are said to have been cut a short distance below the surface. A quantity of ore was shipped from the Cowles claims, on the west side of the range, and gave about 4 per cent of WO_3, a rich lot of ore for contact-metamorphic deposits.

The famous mine of the Atolia Mining Co. continued to hold its title as the largest tungsten mine in the world and of course dominated the Atolia district. In 1918 it yielded ore of a much lower grade and consequently made a much smaller output than in 1917 or 1916. In 1918 the output was equivalent to 1,108 short tons carrying 60 per cent of WO_3.

The output of the mine for 11 years to 1918 was as follows:

Tungsten produced by the Atolia Mining Co., 1908–1918.

Year.	Ore milled.	Concentrates (60 per cent WO_3) produced.	Total value.
	Short tons.	*Short tons.*	
1908	190	15.15	$8,626
1909	5,182	428.77	200,295
1910	6,780	404.76	230,580
1911	4,855	258.96	131,911
1912	8,042	394.95	205,576
1913	7,592	461.92	234,673
1914	4,908	420.09	186,325
1915	5,773	794.35	748,746
1916	17,406	1,843.62	3,662,567
1917	21,913	1,782.80	[a] 1,982,440
1918	28,070	1,108.00	[a] 1,668,553

[a] Estimated at price for which the company's ore was sold during the year, $18.53 per unit in 1917 and $25.11 in 1918. A much larger sum was received in 1917, including receipts for concentrates on hand from 1916.

The ore sold in 1918 brought an average of $25.11 a unit, a total of $1,550,907, from which a dividend of $700,000 was paid, making a total of $5,264,500 in dividends paid by the mine since 1907.

The ore in sight at the end of the year was apparently less in quantity and still lower in grade than that worked during the year, the richest ore exposed in the Union No. 1 workings carrying only 3 per cent of WO_3 and being only 2.5 feet thick. On the second level of the Par claim a vein 10 inches thick carried 15 per cent of WO_3, and the last 12 feet exposed carried 20 per cent of WO_3 but was thinner in the roof. Oscar H. Hershey, the consulting mining engineer of the company, concludes: "It seems to me that, as a whole, the development work in the Union and Par mines has been yielding satisfactory results and there is no good evidence, from a geological standpoint, of an approach to the end of their ore-producing abilities."

Charles S. Taylor, the superintendent, estimates that "there is about eight months' ore in sight, based on the average daily tonnage milled during 1918. There are reasonable grounds to suppose that considerable more ore can be produced, but it is not actually in sight. The grade of the ore to be developed will probably be 25 per cent lower than the average grade milled during 1918."

The ore mined during 1918 amounted to 29,380 short tons, from which 1,309 tons of waste was sorted out. The ore as sorted cost $247,865, or $8.83 a ton. The ore was produced from the different claims as follows:

	Short tons.
Rainstorm	19
Mahood	139
Par	739
Acaley	406
Union No. 1	26, 768
	28, 071

The 28,071 tons milled carried 3.378 per cent of WO_3 (94,824 units). From the sorted ore 1,079 tons of concentrates carrying 61.584 per cent of WO_3 (66,449 units) were produced—a recovery of 70.08 per cent. The tailings carried 28,357 units (1.05 per cent) of WO_3. It will be seen that the tailings pile of the Atolia Mining Co. is very much richer than the ore of the mines working contact-metamorphic deposits near Bishop. A number of schemes for recovering the tungsten from the tailings have been tried, but so far none have succeeded.

During the year 1,520 tons of concentrates were roasted to drive off sulphur, at a cost of $16,783, or $11.04 a ton, and 722 tons were treated for phosphorus and reduced to 654 tons, at a cost of $20,227, or $28 a ton. The cost of milling 1,079 tons of concentrates carrying 61.584 per cent of WO_3 was $431.96 a ton.

During the year 3,846 feet of drifts and crosscuts were driven in the various workings at a cost of $30,313, or $7.88 a foot. The Union No. 1 shaft was sunk 91 feet to the eleventh level (between 1,000 and 1,100 feet along the vein and between 600 and 700 feet vertically) at a cost of $3,050, or $33.52 a foot. The total cost of recovery, including a charge of $50,644.39 for depreciation but nothing for depletion, was $9.67 a unit. Among the factors entering into costs were the loss of men due to the war and to the epidemic of influenza, which was severe, so that the quality of those available was not equal to former standards. Water was struck at the bottom of the Union No. 1 shaft and was estimated by Mr. Taylor to give a flow of 1,500 gallons a minute. If pumped, however, it would probably soon be exhausted.

The Rare Metals Refining Co., on the Jersey Lily group, and several others produced some scheelite from narrow veins in the schists of the Stringer district, north of Atolia, and spent a considerable amount of money in prospecting. A fair quantity of scheelite was also taken from the dry placers of the "Spud Patch," adjoining Atolia on the southeast.

In the Boulder field, Colorado, ferberite was taken from the principal mines in quantity comparable with that mined in 1917, but the output from the lesser mines was so much smaller that the total dropped nearly a third. The Wolf Tongue Mining Co. had bonanza ore in its Cold Spring mine, and was the largest producer in the district. The epidemic of influenza was very severe in Nederland and vicinity, and about 40 persons from a population of possibly 350 are said to have died. At its height philanthropic men of Boulder, who were more or less closely connected with the tungsten industry, established a small hospital at Nederland, and no more deaths occurred.

On June 17 and 18, 1918, the United States Tariff Commission held hearings at Denver on the question of a tariff for tungsten ores. A considerable number of the producers joined in a statement of conditions which was presented to the commission in printed form. In part, the statement was as follows:

BOULDER, COLO., *June 15, 1918.*

UNITED STATES TARIFF COMMISSION,
Washington, D. C.

GENTLEMEN: The mining of tungsten ore in Boulder County is done for the most part under what is known as the leasing system. Conditions upon which leases are operated vary with the conditions existing in each case.

Some of the larger companies operate entirely under the leasing system, others operate both under the leasing system and on company account, and perhaps one or two operate entirely on company account.

As a rule, under the leasing system, more or less of the prospecting and development work is done on company account, and in many instances the leasers are paid footage for drifting or crosscutting to the ore bodies. In all cases a leaser will gain the entire benefits accruing not only from the operations of the company in developing a certain block of ground but also from the operations of leasers who have previously operated and who have for various reasons ceased work and forfeited the lease. It is probably true that any company or leaser operating for the company, when developing ore of average grade, will make a profit at the prices which have prevailed since the discovery of tungsten in Boulder County.

It is unfortunate, however, that the cost of developing an ore body is in very few cases known, nor is it taken into consideration in determining whether or not a profit has been made. It is with extreme difficulty that data, either of cost or production, can be obtained, not only because of the almost countless number of small operators, but because of the fact that no records are kept either of their costs or of the tonnage produced. To most of the small operators in the Boulder district such terms as depletion, selling cost, overhead, and administration are unknown. The average leaser will have a vague notion that he has either made wages or has not made wages, and leasers operating upon small properties are usually in financial difficulty, owing to insufficient capital and machinery with which to develop and operate an ore body economically.

The average grade of ore in Boulder County is perhaps 5 per cent WO_3. The ore occurs in shoots or lenses which are in fairly well defined veins running almost uniformly northeast and southwest through the district. The ore shoots are variable in length and in depth, and the average thickness of the mineral-bearing vein matter is but a few inches. Owing to the brittle character of the ferberite crystal, there is considerable loss in removing the ore from the drifts and stopes; in fact, it is quite the common practice to work over the mill dirt and dumps by means of hand sorting, jigs, and sometimes concentrating tables, the average value in the dumps of producing mines being perhaps ½ of 1 per cent WO_3. This grade of ore and the screenings carrying values would obviously not stand freight and milling charges.

The conditions of mining in the Boulder district have changed greatly since the early days of tungsten mining. There were in the beginning large areas of float, fields from which extremely rich ores could be taken with little or [no] mining expense. In some cases placer mining was resorted to, and tungsten was recovered from the placer deposits by jigs. There were also surface deposits, and in some cases a considerable enrichment of surface veins. It is quite natural, therefore, that tungsten ore should have been mined very cheaply, and it follows that since the tungsten area of this district is relatively small, the ore bodies which could be worked to advantage under the existing conditions were largely developed and depleted.

Only a few companies attempted constructive development of ore reserves, so that when a sudden demand was thrown upon the mines for larger increased tonnage during 1915 and 1916 the demands were met only in part, and an enormous and fictitious rise in price resulted.

The high prices during 1915 and 1916 stimulated prospecting, and it is said that thousands of miners combed the district for tungsten ore. The bodies which were opened before and during this time were exhausted and in almost every case the properties were left in bad repair with ore bodies depleted.

* * *

It is significant that during the excitement and intensive prospecting for tungsten during the period of high prices there were discovered no notable ore bodies of unusual richness or extent. This illustrates perhaps better than any one thing the fact that mining for tungsten should be done along recognized business lines with the observance of strict economy and at all times directed by the highest engineering authority available.

While it is of course true that some few persons have discovered ore bodies and operated them at an excellent profit, little is heard of the countless hundreds of men who in a more or less blind faith and with a hope of striking it rich have spent not only their time, but their cash and credit and have had no returns. * * *

Tungsten producers of Boulder County have been and are now working under a great difficulty in presenting the exact truth of the situation before the proper interested parties. The situation is so vague that it is even difficult to ascertain the exact cause of the misunderstandings which are now existing. For example, companies who have and are now mining tungsten on a large scale are those who have had large capital. They have approached the problem, not with the view of finding immensely rich bodies of ore in order to make a quick fortune, but rather to develop veins carrying ore bodies more or less consistently and keep their development work as far as possible ahead of the actual depletion of the ore bodies. These companies have been successful in mining tungsten and, without doubt, have found the mining of tungsten profitable, but it is true that these companies have during the years 1915–16 drawn upon their reserves and development work, and it is altogether probable that if similar development were to be attempted in the face of prevailing conditions and prices, it could not be accomplished.

In reference to subject (1) "war disturbances," the information obtained from all sources in this county indicates very clearly that the production has been increased over that made before the war. There has been an increase in the price of labor of approximately 40 per cent. [Labor was said to average $4.85 for a day of eight hours.]

The markets for our ore have been increased probably from two to three times their ordinary size. There has been considerable plant expansion, and for two years the conditions of the industry were greatly improved. In comparing the years 1914 and 1917, however, it may be stated that practically all of the cheaply mined ore was extracted during the boom of 1915–16, and, as will be clearly shown from a perusal of the questionnaires submitted herewith, practically all of the production of the county is now coming from below the surface, and, as will also be clearly shown from the questionnaires, it is estimated that the cost of such mining is from three to seven times the cost at surface. It is evident from information obtained that many of the operators are uncertain as to whether they will be able to continue operations at present prices of $20 to $22, and a great many will have to shut down unless better prices than the present ones are obtained. The committee may state from its own knowledge that very little development work compared to the amount of ore produced is being done at the present time, and it believes that the production will materially decrease unless present prices are stabilized or increased. * * * The committee may state that from its own information it believes that unless we receive very material protection by means of a tariff, the tungsten-mining industry of this country will be brought very nearly to a standstill by the competition offered by ores from South America and Asia. The committee believes that the only preparation which may be made for readjustment to post-war conditions is the putting on of a sufficient tariff upon tungsten ores mined in [outside of?] this country.

Answers made by a majority of the producers to the fifth subject proposed in the questionnaire indicate that most of these producers feel they must have a price of from $30 to $40 per unit in order to obtain a reasonable profit in their operations. This estimate, taken in conjunction with the fact that a large majority of the producers are either uncertain whether they can continue at present prices or believe that they must soon stop operations, indicates very clearly that the production in Boulder County will fall off materially unless ample tariff protection is given and, if possible, better prices than the present ones obtained.

The committee may state in reference to the sixth subject on the questionnaire that statistics obtained throughout the county indicate that since 1914 wages have increased from 30 per cent to 40 per cent and materials 100 per cent. * * *

Referring to the ninth subject mentioned in the questionnaire, the data obtained by the Boulder County committee indicate that practically all of the producers agree that the adequacy of American deposits for domestic needs is largely dependent upon the market price and stability of this price. The committee estimates that in the year 1917 there were produced in Boulder County from 2,800 to 3,000 tons of concentrates and that approximately 75 men were engaged directly in the production of this ore. At one time during the 1915–16 boom, when prices were much higher than at present, as many as 3,000 men were directly employed in Boulder County in extracting tungsten ore, which clearly demonstrates that an increase in the price causes many more people to engage in the industry and that there is room in Boulder County for a great many more men to be engaged in this industry and that the production will be stimulated thereby.

(Signed)

Warren F. Bleecker.
Harold Boericke.
William Loach.
C. F. Lake.
L. E. Girard.
Nelson Franklin.

A. Sisson.
John A. McKenna.
John G. Clark.
Frank Armstrong.
Wallace Tanner.

In Arizona the production was equivalent to about 213 short tons of concentrates carrying 60 per cent of tungsten trioxide, valued at $263,100, and it included wolframite, huebnerite, and scheelite. The Yucca Tungsten Co. was the largest single producer. In June the Tungsten Reef Mines Co., of which A. J. Clark is president, took over the control of the Exposed Reef Tungsten Co., whose claims are in the Huachuca Mountains near Hereford. The claims cover a large, rather flat quartz vein carrying scheelite and some gold. The property was equipped with a mill large enough to handle 100 tons of ore a day, and with this mill a recovery of about 10 pounds of WO_3 per ton of ore was made. Machinery for a 250-ton mill was hauled to the ground but was not erected owing to the sudden fall in the tungsten market that followed the signing of the armistice in November. With the larger mill Mr. Clark estimates that tungsten concentrates can be produced at $11 a unit.

In South Dakota the Homestake Mining Co. made a considerable output of wolframite at Lead, and the Wasp No. 2 Mining Co., on Yellow Creek, 2 miles south of Lead, also produced wolframite during the earlier part of the year. Both deposits were replacements in dolomite. A little wolframite was also produced by several others near Lead and Deadwood, and a very little came from the veins near Hill City.

A little scheelite was produced in Box Elder and Tooele counties, Utah; a little huebnerite on Blue Grouse Mountain, near Deer Park, Wash.; some scheelite at Jardine, Mont.; and a few other small lots at other places.

PRICES, THEIR EFFECTS AND CAUSES.

The prices of tungsten ores were fairly steady during the greater part of 1918. Scheelite that was free from phosphorus, sulphur, and other harmful impurities brought about $25 a unit most of the year. The other minerals brought from $18 to $25. The price of impure ores was always a matter of bargaining. Toward the end of the summer and in the fall the demand was very heavy, owing to the huge orders of the Government for war materials. Upon the signing of the armistice, on November 11, orders were canceled, the demand slowed down, and prices fell accordingly. At the end of the year wolframite of good quality that carried more than 60 per cent of tungsten trioxide was offered in New York for $12 a unit.

Large quantities of tungsten ore were in stock and on the road from foreign countries when the armistice was signed, and as prices fell the miners, many of whom had come to believe that the excessive prices of the war time were to be the normal prices, felt that they should be protected from loss, and there arose a great demand for Government regulation of prices, by which was meant the raising of prices, the cutting off of imports for at least three months, and a high tariff. All these demands were given added impetus and made to appear more reasonable by the very great increases, ranging from 50 to 100 per cent, that had taken place in wages, materials, and camp costs. Miners had never lived so well, and probably were never so inefficient. Not only was the cost of furnishing board increased, but if the quality were not high and the quantity ample miners quickly went to another camp, so that many boarding houses were conducted at a loss.

Whether or not the end of the war had been expected by the United States and the associated nations, preparations went on for longer and more effective operations, with the result that about the first of November, 1918, tungsten ores were being used at the rate of 16,000 short tons or more of concentrates a year, and plans were under way that would have increased the annual consumption to fully 20,000 tons.

The high prices that had prevailed in the United States since 1915 had drawn increasing imports of ores from South America and Asia, especially from China, where the most striking discovery in the history of the world's output of tungsten was that of the great, easily worked placer deposits in the southern Provinces.

The tungsten supplies of the United States, as nearly as may be expressed from the data at hand, are shown in the following table:

Supplies of tungsten ores in the United States, 1912–1918, in short tons.

Year.	Production.	Imports for consumption.			Exports.[a]		Apparent consumption.[c]
		Ore.	Tungsten and ferrotungsten.	Estimated equivalent in ore carrying 60 per cent of tungsten trioxide.[b]	Tungsten and ferrotungsten.	Estimated equivalent in ore carrying 60 per cent of tungsten trioxide.	
1912	1,330	824	323	1,620	....	....	2,950
1913	1,537	449	740	2,151	....	....	3,688
1914	990	299	218	814	....	....	1,804
1915	2,332	1,776	8	1,942	....	....	4,274
1916	5,923	3,973	43	4,401	287	580	9,744
1917	6,144	4,876	1	5,284	1,162	2,420	9,008
1918	5,061	11,750	....	12,729	616	1,265	10,525

[a] No record of tungsten ore exported is at hand, although it is known that some has been shipped abroad.

[b] These items include the ore (considered as carrying 65 per cent of tungsten trioxide) and the tungsten and ferrotungsten (considered as equivalent to 2¼ times their weight in ore carrying 60 per cent of tungsten trioxide). Chinese ore imported has been considered as carrying 67½ per cent of tungsten trioxide.

[c] Production plus imports minus estimated equivalent in ore of the exports of tungsten and ferrotungsten. For 1918, 6,000 tons estimated to be on hand at the end of the year was subtracted from the sum of the production and imports. The apparent consumption is at best only an approximation.

USES OF TUNGSTEN.

Tungsten is used mainly as an alloy in high-speed tool steel, for the making of filaments for incandescent lamps, for targets and cathodes of Roentgen (X ray) tubes, for electric contacts to be used in explosion engines, and wherever an intermittent electric contact is needed. In its minor applications tungsten is added to saw steel and some other steels, and is used as a constituent of stellite, in a tungsten-iron alloy for valves in automobile and airplane engines, in a manganese-chromium-tungsten-iron alloy for wire-drawing dies, in wire cloth for kenotrons and similar instruments, in luminescent screens for Roentgen rays, in mordants, and in minor chemicals.

SUBSTITUTES.

The use of tungsten in high-speed steels is as standard as the use of yeast in bread, and though substitutes have been assiduously sought, none has been found that will satisfactorily take its place for that purpose. It is said that in England and France molybdenum has been used to replace about half of the tungsten in some high-speed tool steels, but it is apparently not a preferred metal, being used only when it is difficult to obtain tungsten. In this country the practice has had few sponsors, and the following quotation from the Mining Journal (London) for May 25, 1918, page 218, shows that this substitution was not then favorably regarded abroad: "The manufacture of ferromolybdenum is stated to have been commenced in Sweden, where the lack of ferrotungsten has forced the employment of this substitute."

During 1917 104 (metric?) tons of molybdenite was shipped from Norway to Germany, where it was apparently used in the same way as in Sweden. Henry E. Wood reported finding molybdenum in the steel of a German helmet.

When tungsten was at the excessively high price of the early part of 1916, many experiments were made to find a substitute, but apparently without full success, though lately several substitute steels containing cobalt and chromium and especially intended for cast milling cutters and other multiple-edge tools have been placed on the market, and a cobalt-chromium-molybdenum steel and a uranium steel have been offered for lathe tools. Stellite, the colbalt-chromium-tungsten alloy in which there is only one-third to one-half as much tungsten as is used in high-speed steel, has grown in favor, and cooperite, a nickel-zirconium alloy, is also a competitor for this market, but the trade in all these combined has made no appreciable impression on the demand for tungsten steels.

A change in the manner of using tungsten steel by which a thin plate of high-speed steel is welded to an ordinary steel bar so as to form the cutting edge of a lathe tool has made the demand for tungsten less than it would have been had the old practice of making the whole tool of high-speed steel been followed.

CHANGES IN PRACTICE.

No striking changes in practice in the metallurgy of tungsten are known to have taken place during 1918, but there has been a steady betterment of the art, an improvement in the quality of the ferrotungsten, a shifting in localities of reduction, and considerable changes in the manner of use. The wasteful demand for ores of high concentration and of great purity common before the war has given way to more enlightened and intelligent practice, until firms both in this country and in England make a specialty of using low-grade or impure ores, though apparently much more advance has been made here than abroad. One firm, the Chemical Products Co., of Washington, D. C., was organized specifically to buy ores carrying less than the 60 per cent of tungsten trioxide (WO_3) demanded by other American firms and ores containing sulphur, copper, arsenic, bismuth, tin, antimony, phosphorus, or other impurities to which most users objected. The Black Metal Reduction Co. and the Tungsten Products Co., both of Boulder, Colo., were organized to handle materials such as tailings carrying as little as 1 per cent of tungsten trioxide, and they stated that they were able to pay for gold and silver in the ore. Several firms make tungsten trioxide or tungstic acid (H_2WO_4) for ferrotungsten makers. Firms have also made artificial scheelite ($CaWO_4$) for the same trade, using off-color ores in the process. Powdered ferrotungsten made by chemically precipitating an iron-tungsten salt from solution and reducing it to a metallic powder carrying from 4 to 11 per cent of iron has been put out by several firms and has apparently started a demand for powdered ferrotungsten, so that firms are now finely grinding the massive ferrotungsten. It is also claimed that better furnace practice greatly cuts down the consumption of current and increases the saving from the usual 80 per cent to 90 or 96 per cent of the tungsten in the ore. Several firms now make ferrotungsten powder and tungsten powder in iron tubes or other iron containers instead of in the graphite crucibles used before the war. In the milling of tungsten ores the tendency in this country is to get away from the uneconomic method of making concentrates very high in tungsten trioxide (carrying more than 60 per cent of WO_3). Few operators really know what the millheads run, and the determination of losses is mere guesswork. Some of the most careful operators in the Boulder field before closing down at the beginning of 1919 were making not only a high-grade product carrying nearer 50 per cent than 60 per cent of tungsten trioxide but also a lower-grade product carrying about 20 per cent of tungsten trioxide, not attempting to raise its tenor. This practice cuts down the losses largely. When the great shortage of tungsten ore came on in 1916 users were compelled to take lower-grade concentrates, and some of them improved their metallurgy accordingly. This has made the sale of 50 per cent concentrates easier. Even in England 60 or 65 per cent ores were accepted where formerly a content of 67.5 or 70 per cent of WO_3 was demanded.

Formerly scheelite sold at 50 cents a unit less than other tungsten minerals, even though it was freer from bothersome impurities; but with the graduation from rule-of-thumb methods to more thoughtful, careful practice, it now commands a premium of $3 or $4 a unit. Huebnerite, apparently, is still sold with and as "wolfram" in England, but in this country it must be sold according to its composition, for to most metallurgists the manganese is undesirable, though at least one firm has advanced to the point where it makes ferrotungsten from huebnerite without prejudice or difficulty. This growth in knowledge and technique has caused the tungsten minerals to take about the following relative rank in value: Scheelite, $23-$24; ferberite, $22; wolframite, $20; and huebnerite, $19 per unit. These prices apply to tungsten ores used in the manufacture of tungsten products and ferrotungsten for making steel. Scheelite is not wanted in this country for making filaments.

Before the war the United States imported considerable quantities of ferrotungsten from Germany, but metallurgists claim that the ferrotungsten now made in this country is superior to any imported from Germany. The German export trade is of course dead for the present. During the year England, formerly a small producer, made large quantities of ferrotungsten and tungsten powder at a number of plants. One of the producers, the High Speed Steel Alloys (Ltd.), Widnes, near Liverpool, "is under Government assistance and is owned by 31 of the leading consumers of Sheffield."[1] The article quoted stated that the output was at the rate of 500 tons of tungsten a year. The Thermo-Electric Ore Reduction Corporation,[2] Luton, was at the same time producing 140 tons of tungsten a month. The ferro produced carried 80 per cent and the powder 98 per cent of metallic tungsten. By way of comparison it may be stated that only one company in this country was producing as much as 60 tons of tungsten a month during the same war period. The Thermo-Electric Ore Reduction Corporation owned mines from which it expected to produce each year 4,000 long tons of concentrates carrying 65 per cent of tungstic oxide. There are at least seven other manufacturers of tungsten or ferrotungsten in England.

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[1] High Speed Steel Alloys (Ltd.); Visit of inspection to the works: Min. Jour. (London), vol. 115, p. 779, Nov. 25, 1916. Since this article was written there has appeared an article by Julius L. F. Vogel (Min. Jour. (London), vol. 20, p. 16, January, 1919) in which he states that Government aid, though proffered, was not accepted. This statement confirms the idea that it was a Government policy to assist financially private firms in the tungsten business.

[2] Thermo-Electric Ore Reduction Corporation (Ltd.); Visit to the Luton works: Min. Jour. (London), vol. 115, p. 797, Dec. 2, 1916.

France had a number of ferrotungsten plants before the war, and these are thought to be still in operation.

At the beginning of the war about half of the tungsten used in this country was introduced into steel in the form of ferrotungsten and about half in the form of tungsten powder. This practice has changed so that now more than three-fourths of the tungsten used is introduced into steel as ferrotungsten, seemingly in large part because of the purer form in which ferrotungsten is now manufactured and in part because for a while tungsten powder could not be obtained. At one time tungsten ores were put in the charge and the tungsten alloyed directly with the steel; in fact, tungsten steels were first made in this way, although the process was patented in this country as new, but the practice seems to have been dropped on account of the impurities that were introduced into the steel and that may be eliminated when tungsten or ferrotungsten is made first. A considerable change has taken place in the making of tungsten steels through the increased use of the electric furnace. One considerable producer, the Latrobe Electric Steel Co., makes all of its high-speed tool steel in the electric furnace, and the Vanadium Alloys Steel Co., one of the larger producers, makes a large part of its steel in the same way. It is understood that the Crucible Steel Co. and some other steel companies also make a part or all of their high-speed steels in the electric furnace.

The removal of tin, copper, and other impurities from ferrotungsten by grinding and chemical treatment has made possible the use of impure ores in the production of high-grade ferrotungsten in the electric furnace.

GEOLOGIC DISTRIBUTION.

Tungsten, even more than tin, is found almost exclusively with granitic rocks. In a few places tungsten deposits are found in volcanic, sedimentary, or metamorphic rocks, but as is postulated for certain tin deposits, many of these deposits may be explained on the supposition that the vertical distance from them to underlying granite is not great.

The deposits themselves exhibit a considerable variety of forms and may be classed as segregation deposits, pegmatite dikes, veins, replacement deposits, contact-metamorphic deposits, and placers. Segregation deposits are few and of little value. They comprise those deposits in which wolframite is segregated in granite like biotite or hornblende. A closely related group comprises the deposits in which tungsten minerals occur in aplitic granite, and these grade almost insensibly into the pegmatites.

The pegmatites are also of comparatively small value but they yield certain quantities of tungsten minerals. They grade into the well-defined veins, which have heretofore furnished the greater part of the tungsten minerals of the world. By " vein " is meant a tabular body of rock that has been deposited from solution in a preexisting fissure or cavity. In most veins quartz is the predominant mineral. but, as in Boulder County, Colo., the tungsten mineral may form nearly the whole vein. In the principal scheelite veins at Atolia, Calif., calcite forms most of the gangue. In a large scheelite vein examined by the writer in Bolivia the gangue is chiefly adularia, and in another it is barite. A large ferberite vein in the same general region has siderite as a gangue mineral.

Closely connected with the well-defined veins are the replacement deposits, in which the country rocks alongside cracks, though the cracks may be very narrow, are replaced by various minerals, including those of tungsten. The only known large examples are the wolframite deposits near Lead, S. Dak., which were considerable producers under the high prices of the Great War. Among the replacement deposits are to be noted also certain deposits, such as those in the Deep Creek Mountains, Utah, in which solutions following cracks in monzonite have replaced the rock adjacent to the cracks with a coarse mass of actinolite, feldspar, quartz, tourmaline, apatite, scheelite, wolframite (very little), bismuthinite, chalcopyrite, and molybdenite—an aggregation of minerals which under other conditions would be unhesitatingly called pegmatite.

Closely related to the replacement deposits are the contact-metamorphic deposits. These have only recently begun to be of commercial importance, but they promise to be among the greatest, if not the greatest, producers of this country, and possibly of other countries. They are of the familiar kind, limestones or limy rocks, which have been invaded by granitic intrusives that brought with them large quantities of watery or gaseous solutions of silicon, iron, aluminum, and magnesium, with less chlorine, fluorine, soda, potash, copper, zinc, titanium, phosphorus, molybdenum, and sulphur, with more or less tungsten, and these substances combined with and metamorphosed the limestones. In the Great Basin broad areas of limestone, extending from northwestern Utah to the Sierra Nevada and around its southern extremity, have been thus intruded and metamorphosed. Some large deposits of scheelite have already been exploited in this region, and others remain to be worked. Similar deposits occur in Chosen (Korea), Japan, and Tasmania, and probably exist, though as yet undiscovered, in China, the Malay Peninsula, and other countries. The tungsten mineral in such deposits is invariably scheelite.

Placers are formed from all classes of deposits, but their value depends largely on local conditions. They comprise both residual and fluviatile deposits, and have been large producers of tungsten minerals, especially of wolframite. A very large proportion of the Burmese output has been obtained from semiresidual and stream placers, and the Chinese output in 1918, the largest ever made by a single country in one year, was derived almost wholly from placers.

GEOGRAPHIC DISTRIBUTION.

The distribution of tungsten ores is far from being as wide as the distribution of the granitic rocks, and some regions that contain large areas of granite have almost no tungsten minerals—for example, the Scandinavian peninsula, large stretches of Siberia, Canada, the eastern United States, and Brazil.

The world's known large tungsten fields are grouped along the shores of the Pacific Ocean—not all very close to it, but somewhere in the great mountain masses that parallel its margin—and the Asiatic shore is much richer than the American shore. In 1918 nearly 92 per cent of the world's tungsten came from the Pacific shores, and here the Colorado and South Dakota deposits are included as nearer the Pacific; the west side furnished more than 62 per cent, including more than 57 per cent from Asia, and the east side produced a little more than 29 per cent, about equally divided between North America and South America. There is only one considerable tungsten-bearing area not situated close to the Pacific—that of the Iberian Peninsula, mostly in Portugal, but partly in Spain. This area produced nearly two-thirds of the more than 8 per cent not produced around the Pacific. There are small deposits in England, Germany, and other places near the Atlantic, but together they produce less than 3 per cent of the world's output of tungsten ores. The huge continent of Africa has only negligible known deposits; none of consequence are found on the borders of the Arctic, Antarctic, or Indian oceans, except along the narrow Malay Peninsula, and only minor deposits are known in Siberia.

Considered as a single metallogenic province, by far the greatest producer is southeastern Asia, which includes the Malay Peninsula; Burma, including the Shan States; Siam; French Indo-China (Tonkin); and southeastern China. The second largest producing metallogenic province comprises the western United States and Mexico,[1] to which the Cordilleran province, including Bolivia and the adjacent closely related areas of Peru, Argentina, and Chile, would be a close third. Japan and Chosen are fourth in importance and form a rather distinct province which may continue into Manchuria. Australia and Tasmania are next in importance and also constitute a distinct province, practically all the ores being found in the eastern ranges. There are numerous small more or less isolated areas like Connecticut, Nova Scotia, and Manitoba. They are at present negligible and give no promise of future importance.

WORLD'S PRODUCTION.

The world's production of tungsten ores by metallogenic provinces and political areas is shown in the following table:

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[1] It may be quite justly objected that the idea of a metallogenic province is considerably stretched to make it include the Colorado and Black Hills deposits with those of the Southwestern States and Mexico; but for convenience they are here so grouped, with a frank confession of the license taken.

World's production of tungsten ore, 1913–1918, by metallogenic provinces and political areas, in metric tons (2,204.6 pounds) of concentrates containing 60 per cent of WO_3.

Province and area.	1913	1914	1915	1916	1917	1918
Asia.						
Japo-Korean province:						
Japan	257	204	389	730	763	629
Chosen (Korea)	....	....	67	555	900	1,097
Chino-Malayan province:						
China	....	18	35	109	1,361	10,187
Tonkin	127	162	333	343	433	450
Burma and Shan States	1,572	2,166	2,464	3,464	4,226	4,138
Siam	280	273	432	530	726	185
Unfederated Malay States	114	172	159	317	334	1,156
Federated Malay States	248	288	329	524	721	362
Billiton and Singkep	6	1	6	47	8	55
Indian province:						
India (excluding Burma)	....	....	....	46	68	44
	2,604	3,284	4,214	6,665	9,540	18,303
Australia.						
Australian province:						
Queensland	533	401	642	456	471	357
Northern Territory	32	45	36	137	252	275
New South Wales	200	221	99	313	268	279
Victoria	1	....	....	1	....	....
South Australia	....	....	....	1	....	....
Tasmania	81	56	112	144	286	440
Western Australia	1	1	....	....	....	....
	848	724	889	1,052	1,277	1,351
Oceania.						
Oceanic province:						
New Zealand	262	242	230	315	235	170
South America.						
Cordilleran province:						
Chile	....	....	....	9	2	....
Argentina	575	437	169	854	1,056	613
Bolivia	297	290	859	3,288	4,215	3,705
Peru	324	213	413	532	427	251
Brazilian province:						
Brazil	....	....	....	5	....	....
	1,196	940	1,441	4,688	5,700	4,567
North America.						
Southwest American province:						
Mexico	....	....	140	159	308	239
United States	1,394	898	2,116	5,330	5,545	4,578
Alaskan province:						
Alaska	....	....	....	43	29	13
Canadian province:						
Southeastern Canada	11	....	....	....	....	15
	1,405	898	2,256	5,582	5,882	4,845
Europe.						
Scandinavian province:						
Norway	3	5	....	1	1	....
Sweden	....	....	....	....	....	3
Franco-Cornish province:						
England	197	222	360	407	245	308
France	160	145	126	162	261	212
Iberian province:						
Portugal	1,126	667	953	1,418	1,580	1,150
Spain	169	135	189	425	446	579
Italy	....	....	....	5	1	....
Erzgebirgan province:						
Germany	96	108	193	330	300	300
Austria	52	57	14	10	10	10
Russian province:						
Russia	....	....	....	33	33	33
	1,803	1,339	1,835	2,791	2,877	2,595
Africa.						
South African province:						
South Africa	5	....	1	3	12	34
	8,123	7,427	10,866	21,046	25,523	31,865

NOTES ON THE WORLD'S PRODUCTION OF TUNGSTEN ORE.

Japan.—The bureau de la statistique de l'Empire du Japon, Cabinet impérial (Résumé statistique de l'Empire du Japon, 33ᵉ année, Tokyo, 1919, pp. 22–23), gives the production of tungsten ores as shown in the table below. The exports are taken from a report by the Japanese Bureau of Mines (Department of Agriculture and Commerce), entitled "The mining industry of Japan in 1918, its general situation," Tokyo, 1919, page 66. No imports are shown. The Japanese tungsten ores imported into the United States carry from 61.25 to 65.5 per cent of WO_3. The average has been arbitrarily fixed at 62.5 per cent.

Japanese tungsten ore produced and exported, 1908–1918.

Year.	Production.		Exports.	
	Kwan (8.2673 pounds).	Equivalent in metric tons, 60 per cent WO_3.	Quantity (kwan).	Value (yen).
1908	310	1		
1909	5,705	23		
1910	28,217	110		
1911	31,812	120		
1912	45,337	177		
1913	65,811	257		
1914	52,082	204		
1915	99,354	389	128,976	460,042
1916	186,444	730	143,392	1,836,774
1917		[a] 763	191,904	1,709,649
1918		[b] 629	319,824	2,821,984

[a] Clements, J. M., Statistics of Japanese mineral production: Commerce Reports, Feb. 19, 1919. Quotes figures compiled from the monthly reports of the Japanese Bureau of Mines by an officer of the Association of Mine Owners (Kozan Konwakwai). The figures are given as 721 [long] tons.

The statistics of production of Japanese tungsten ore gathered by various agencies do not altogether agree. Mr. Clements, in a manuscript report to the Bureau of Foreign and Domestic Commerce, 1920, p. 322, says: "The first year in which the production of tungsten ore is recorded is 1908, when 1.28 short tons was produced, with a value given as $244. By 1910 the production had reached 117 short tons, valued at $43,310.

Production of tungsten ore.

Year.	Quantity (short tons).				Value.
	Scheelite.	Wolframite.	Character not known.	Total.	
1912	66	73	48	187	$70,748
1913	96	105	71	272	115,560
1914	80	121	14	215	93,481
1915	231	150	30	410	238,019
1916	371	174	226	770	1,152,206

"The total production of tungsten ore in Japan from 1908 to 1916 is 2,127 short tons, valued at $1,722,190."

[b] H. W. Paul (Bergbau und Hüttenwesen Japans im Kriege: Glückauf, vol. 56, p. 695, Aug. 28, 1920) gives the production during 1918 as 604 metric tons, valued at 1,420,000 yen.

The mines producing tungsten ores valued at more than 10,000 yen in 1918 are given in "The mining industry of Japan in 1918, its general situation," pp. 17–32, Tokyo, 1919, as follows:

Name of company.	Location.	Quantity (kwan).	Value (yen).
Tanaka Mining Co	Yamaguchi	49,753	402,884
Awamura Mining Co	do	51,179	396,615
Kyoichi Sadanaga et al	do	5,742	41,370
Koeki Shokusan Co	Okayama	2,537	16,896
Yebisu Mining Co	Gifu	10,534	82,910
Mitsui Mining Co	do	3,677	32,140
Mitsubishi Mining Co	Ibaraki	31,064	378,674

Chosen.—1917: Min. Jour. (London), volume 121, page 331, June 1, 1918, gives the production of tungsten ore in Chosen as follows, in long tons of concentrates carrying between 60 and 70 per cent WO_3: 1915, 61 tons; 1916, 505 tons; 1917, 818 tons. Supposing the percentage of WO_3 to be 65, the quantities are equivalent, respectively, to 74, 612, and 992 short tons of concentrates carrying 60 per cent WO_3. Scheelite and less wolframite.

1918: Clements, J. M., Report [to the director, Bureau Foreign and Domestic Commerce] on a reconnaissance of the tungsten resources of Korea (Chosen), page 2, June 14, 1920. The production is given as 1,116 short tons, and from the context it is thought to have carried 65 per cent WO_3.

China.—1917: Estimated. George E. Anderson, American consul at Hongkong, under date of September 13, 1917 (Commerce Reports, Nov. 9, 1917, p. 546), reports that 230 [long] tons of tungsten ore had been shipped and 500 tons was on hand in Hongkong at that time. The ore probably carried 67.5 per cent or more WO_3, so that the two quantities were probably equivalent to 920 short tons of concentrates carrying 60 per cent WO_3. Nearly one-fourth of the year remained for further production. Tungsten was also being produced by the Yu Hao Tungsten Mining Co. near Chunchow, in Hunan, that would be shipped by way of Shanghai, and probably some ore was shipped by way of Swatow, from mines in Kwangtung.

1918: British Chamber of Commerce Jour., Shanghai, March, 1920, page 91. "The chief exporting port is Hongkong, which is within easy distance from the chief producing centers. In 1918 the total export from China was 155,485 piculs." The picul is equal to 133⅓ pounds. Chinese ore is largely of high grade, and it is here treated as 65 per cent WO_3, so that the figures given are equivalent to 11,229 short tons, or 10,187 metric tons, of ore carrying 60 per cent WO_3. No value is given for this ore, but 109,909 piculs (7,327 short tons, or 6,649 metric tons) shipped from Hongkong was valued at £1,267,789. Of the ore shipped by way of Hongkong, 80 per cent is said to have gone to the United States, and less than 10 per cent to the United Kingdom. Thomas Sammons, United States consul general at Shanghai, reports (Jan. 25, 1919) shipments from that port to the United States of tungsten ore valued at $543,300, probably about 545 tons, but there are no reports from Swatow, Canton, Hankow, or other ports.

No shipments of tungsten ore reached the United States from Hongkong until April, 1918. Between April 1, 1918, and March 31, 1919, 5,225 short tons of ore arrived from that port, showing that the lag in shipments was about three months. During the same period the United States received from other Chinese ports 3,150 short tons of ore, a total of 8,375 short tons. As stated above, Chinese ore is generally high in WO_3 and may probably be accepted as 65 per cent WO_3, so that the imports would be equivalent to fully 9,300 short tons of concentrates carrying 60 per cent WO_3. It is known that Japan took some Chinese ore, most of which was probably reconcentrated and shipped to the United States, so that this country probably took 10,000 short tons, the remainder going to France and Great Britain.

Tonkin.—Office colonial, Ministère des colonies, Statistique de l'industrie minière dans les colonies françaises (for various years), Paris. The output for 1917 is given as follows:

Name of mine.	Owner.	Production (metric tons).	Exports.		Content (per cent).	
			Quantity (metric tons).	Value (francs).	WO_3.	Sn.
St. Alexandre..	Société d'Etains et Wolframs du Tonkin.	222 (wolframite).	222 (wolframite).	2,200,000	72	....
		70 (cassiterite)..	12 (tin)........	....	......	60
		8 (mixed).....	....	....	......	....
Beau-Site......	Société des Mines d'Etain du Haut-Tonkin.	99 (mixed).....	97 (mixed).....	340,000	50	10
Andrée.........	M. Pham-van-Co, operated by M. Ducreux.	....	....	....	32	34
Man-muc.......	M. Rochat..............	76 (mixed).....	89 (mixed).....	356,000	43	22
Ariane.........	....	33 (mixed).....	....	....	......	....
Phèdre.........	....	8...........	44 (mixed).....	130,000	30	30
Ganymède.....	....	3...........	....	....	......	....
	....	519	464	3,026,000	......	....

1918: Estimated.

Burma and Shan States.—1917 and 1918: Hayden, H. H., The mineral production of India during 1917; India Geol. Survey Rec., vol. 49, pt. 2, p. 73, 1918; during 1918: Idem, vol. 50, pt. 3, p. 161, 1919.

Tungsten ore produced in India during 1917 and 1918.

	1917		1918	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Bihar and Orissa:				
Singhbhum	20	£1,333	2.5	£498
Burma:[a]				
Kyaukse	....	....	.1	17
Mergui	368	49,541	376.6	52,490
Southern Shan States [b]	307	39,910	287	41,615
Tavoy	3,697.5	508,794	3,636.1	610,833
Thaton	107.5	15,366	91.5	13,663
Rajputana:				
Narwar	42	8,130	37.4	7,206
	4,542	623,074	4,431.2	726,321

[a] Figures taken from "Notes on the mineral production of Burma" for 1916 and 1917.

[b] The tin ore of the Southern Shan States is produced in the form of mixed cassiterite-wolfram concentrates; the output is therefore returned in terms of the mixed concentrate, the approximate composition of which is usually 43 per cent wolfram to 57 per cent cassiterite. The total figure for 1917 is 14,239 hundredweight; for the purpose of this review it has been assumed that 8,068 hundredweight of this represent tin ore and the remainder wolfram.

The Journal of the Society of Chemical Industry (vol. 37, p. 296 R, 1918) says that "it is authoritatively stated" that 15 to 20 per cent should be deducted from the Burmese ore for tin, and C. Sutton (Min. Jour., London, Mar. 15, 1919, p. 155), retiring president of the Tavoy Chamber of Mines, estimated that 13,000 long tons of tungsten ore, carrying 55 per cent of WO_3 and 15 per cent Sn, had been shipped during the war. The concentrates from Singhbhum, Mergui, Tavoy, and Thaton have been treated in the table as carrying 55 per cent WO_3. As bearing on the WO_3 content of Burmese concentrates, the following statements are also of interest: In 1917 1,450 [long] tons of concentrates from the Hermingyi and Tavoy concessions carried 50 per cent WO_3 and 20 per cent Sn (Min. Jour., London, Mar. 30, 1918, p. 201). Concentrates from the Hermingyi concession alone contained 40 per cent WO_3 and 30 per cent Sn; 1,000 [long] tons produced in 1917 gave 570 tons of concentrates carrying 70 per cent WO_3. The Mawchi mine, at Bawlake, produced in the year ended July 31, 1916, 365 tons of concentrates carrying 31.4 per cent WO_3 and 33.4 per cent Sn (Min. Mag., London, vol. 17, p. 10, 1917) and in the following year 639 tons (Min. Jour., July 20, 1918, p. 442). The ore from Marwar and that from the Southern Shan States (see note (*b*) under the table) is treated as carrying 65 per cent WO_3.

Siam.—Hansen, C. C., Siamese tungsten situation: Commerce Reports, September 6, 1919, page 1254: "The earliest available statistics of Siam's tungsten industry are those for the fiscal year ended March 31, 1912, when the amount of wolframite recovered amounted to 119 [short] tons. This ore, however, had been known to the Chinese tin miners for a long time as 'dead ore,' but at that period its commercial value was unknown, and it was left in great heaps as valueless material, after having been separated from the tin ore. In the fiscal year 1912–13 the production of tungsten amounted to 309 tons, and it was reported that the future output was likely to be less. On the contrary, however, the amounts * * * increased, reaching 584 tons in the fiscal year ended March 31, 1917, and for the succeeding 12 months the output is said to have approximated 800 tons. * * * The high-grade ores * * * contain from 60 to 72 per cent WO_3, but quantities of mixed ores, composed of nearly equal parts of tin and tungsten, have also been recovered. Both wolframite and scheelite have been found, but the former is the more common."

In Commerce Reports for March 24, 1917, Hansen gave the output for 1914 as 4,517 piculs (602,267 pounds), and in the issue of May 1, 1918, he said: "The total wolfram production in the fiscal year ended March 31, 1917, was 8,767 piculs against 7,128 in the previous year." In a report dated July 9, 1920, he quotes the output of Puket in 1918 at 595 piculs and of Nakon Sritamarat as 2,455 piculs. From these data the figures may be itemized thus:

Tungsten ore produced in Siam, 1911–1918.

Year.	Pikuls.	Short tons.	Metric tons.
1911		119	107
1912		309	281
1913			[a] 280
1914	4,517	301	273
1915	7,128	476	432
1916	8,767	584	530
1917		800	726
1918	3,050	203	185

[a] Estimated.

The ore is mined chiefly in Nakon Sritamarat and is mostly wolframite but partly scheelite. Some scheelite is found in the district of Trang. Most of the ore is shipped to Singapore or Prai, Federated Malay States, for the separation of cassiterite by electromagnetic separators. (Reports of Mar. 2 and Oct. 17, 1918.)

Unfederated Malay States.—Trengannu: Humphreys, J. L., Annual report of the British agent, Trengannu, for the year 1918: Reports for 1918 on the Unfederated Malay States under British protection, page 5, Kuala Lumpur, 1919. The exports of tungsten ore (wolframite) in 1918 were 10,368 pikuls, valued at 832,288 Straits dollars, and these figures are used in the table, rather than the output which is given below. The figures of labor and output of the wolfram mines were as follows:

Name of mine.	District.	Labor force.	Output (pikuls).
Dungun (Ltd.)	Dungun	[a] 900	4,516
Chenderong	Kemaman	300	[a] 6,500

[a] Approximate.

The Dungun mine, owned by Dungun (Ltd.), is leased to Lim Chui Chian, a Chinaman, for $1,500 (Straits) a month, besides which one-tenth of the ore is paid to the Government. The mine is on Dungun River and carries some cassiterite. The material, in the absence of definite data, is treated as carrying 60 per cent WO_3.

Johore: Hallifax, F. J., acting general adviser to the government of Johore, Johore annual report for 1918: Reports for 1918 on the Unfederated Malay States under British protection, page 1, Kuala Lumpur, 1919. Exports of wolframite in 1917, 35 pikuls, valued at $2,200 (Straits); 1918, 11 pikuls, valued at $800. The content of WO_3 is not given.

Kedah: Hall, G. A., The annual report of the British adviser to the Kedah government for the year 1336 A. H. (Oct. 17, 1917–Oct. 6, 1918), page 4. The following details of the principal mines are given:

"(*a*) Mr. Russell's mine, at Sintok, in North Kedah: At the end of 1335 a prospecting license was granted to Mr. J. A. Russell, giving him mining rights over a considerable area of land in the Sintok Valley, in which it was known that a deposit of wolfram existed and was being illegally worked by gangs of coolies whom it was impossible to control or locate. Mr. Russell met with considerable difficulty from the start, not the least being the want of communications and sickness among his labor force. A condition of the license was that the deposits should be developed as rapidly as possible with a view to an immediate output of mineral. During the year 8,377 pikuls of mixed ore were won, which, after magnetic separation, resulted in 4,840 pikuls of wolfram and 2,328 pikuls of tin ore, the balance of 1,209 pikuls being loss on separation consisting mostly of iron and arsenic pyrites. In six places outcrops have been discovered, all carrying mineral contents which are now being worked open cast. The original find has been opened up for a length of 1,000 feet along the lode and to a depth of 100 feet; the other outcrops are being worked in a similar manner. Preparations are in hand for sinking a shaft on the main lode to a depth of 250 feet, with the object of testing the values of the lode in depth. The importance of the information to be gained by sinking this shaft is obvious. A dispensary and police station were built at Sintok village. At the end of the year the labor force, which at one time reached 1,000 men, had decreased to about 700. An average of 550 cases monthly are attended to at the dispensary; in addition, a good deal of work was done to improve the insanitary surroundings of the village. The earth road from Changlun proved insufficient for the needs of a rapidly opening district, and considerable difficulty in transport was experienced in consequence.

"(*b*) Loke Chow Thye's mine, at Ayun: This is the only other mine in the State of any importance; 210 coolies are employed, and work is carried on in an old river bed by means of a hydraulic elevator. The possibilities of this valley, as elsewhere in the State, are very largely dependent on the supply of water at any given time. A trace has been made for a road to connect Ayun with the Kuala Nerang road, and a certain amount of earth work done. The scarcity of water will prevent any very great increase of mining in North Kedah or around Semiling, which are the two busiest mining districts at present, and the enormous stretches of padi in the center of the State forbid any ground sluicing in the upper reaches of the rivers; 1336 has experienced a probably unprecedented increase in revenue and output; it can hardly be expected that 1337 will have a similar increase over 1336, but there is no reason to fear that there will be any decrease. The following table gives the usual figures for the last five years:

	1914 (A. H. 1332).	1915 (A. H. 1333).	1916 (A. H. 1334).	1917 (A. H. 1335).	1918 (A. H. 1336).
Tin ore........................pikuls..	14,460	14,582	11,414	8,004	13,068
Wolfram........................do....	421	220	287	2,090	8,730
Value................Straits dollars..	724,320	713,470	647,850	690,989	2,040,292
Number of coolies....................	2,768	3,871	3,397	2,287	4,052

The content of WO_3 is not given, but is considered as 60 per cent. The distribution of the exports from the various States through the years is as follows:

	1912		1913		1914		1915	
	Quantity (pikuls).	Value (Straits dollars).	Quantity (pikuls).	Value (Straits dollars).	Quantity (pikuls).	Value (Straits dollars).	Quantity (pikuls).	Value (Straits dollars).
Trengganu...........	1,208	....	1,400	67,215	2,403	109,389	2,409	147,561
Kedah...............	368	....	478	....	421	....	220	....

	1916		1917		1918	
	Quantity (pikuls).	Value (Straits dollars).	Quantity (pikuls).	Value (Straits dollars).	Quantity (pikuls).	Value (Straits dollars).
Johore................................	382	21,600	35	2,200	11	800
Trengganu.............................	4,554	366,578	3,378	270,227	10,368	832,288
Kedah.................................	287	....	2,090	....	8,730	....

Federated Malay States.—F. M. S. Government Gazette, Suppl., July 18, 1919, p. 45: The production of tungsten ores in each State, after correcting export figures for interstate trade and for ore other than Federated Malay States origin that was reëxported, was, as nearly as can be ascertained, as follows, in pikuls (133⅓ pounds each):

State.	1916	1917	1918
Perak	3,645	6,861	2,515
Selangor	3,837	4,606	3,004
Negri Sembilan	1,132	423	435
Pahang	46	15	17
Total, pikuls	8,660	11,905	5,971
Total, metric tons	524	721	362

Of the production in 1918, 4,097 pikuls (248 metric tons) was wolframite and 1,874 pikuls (114 metric tons) was scheelite. The content of WO_3 is not known and is considered as 60 per cent. No value is given.

Billiton and Singkep.—1917 and previous years: Jaarboek van het Mijnwezen in Nederlandsch Oost-Indië. Neither value nor content of WO_3 are given.

1918: Estimate by the Allies when they proposed to allocate the tungsten supplies of the world among themselves—50 long tons of 65 per cent WO_3.

India (excluding Burma).—1917 and 1918: Singhbhum and Marwar. See note on Burma.

Queensland.—1917 and 1918: Queensland Under-Secretary for Mines, annual report for the year 1918, page 28, Brisbane, 1919. The figures as given are as follows:

	1917			1918		
	Quantity.		Value.	Quantity.		Value.
	Long tons.	Hundredweight.		Long tons.	Hundredweight.	
Wolfram	352	14	£58,367	248	13.5	£43,041
Wolfram and bismuth	131	5	21,172	114	6	18,041
Wolfram and scheelite	1	....	181	....	17.5	169
Scheelite	9	....	1,523	17	5	3,495

The WO_3 content of the wolframite and scheelite is estimated to have been about 65 per cent. The "wolfram and bismuth" is treated as being half wolframite concentrates.

Northern Territory.—Knibbs, G. H., Official Yearbook of the Commonwealth of Australia, No. 12, pages 443, 452, 1080, Melbourne. Commonwealth Bureau of Census and Statistics, 1919. Only the value of the output is given, as below. In the second column of the table are given the prices as quoted in the Mining Journal (London), volume 126, page 545, August 23, 1919:

Year.	Value of wolframite.	Price per long-ton unit of WO_3 (22.4 pounds) in concentrates carrying 65 per cent or more WO_3.	Probable quantity (metric tons).
1913	£3,140	33–34 s. at camps	32
1914	4,025	30–33 s. at camps	45
1915	5,278	55 s. c. i. f. London	36
1916	20,269	.....do	137
1917–18	[a] 39,138	50 s. at camps [b]	252

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[a] The 1917–18 output includes scheelite valued at £350.

[b] The Queensland Government Mining Journal (vol. 19, p. 51, Feb. 15, 1918, announces a raise in price from 50s. per unit to 52s. 6d. per unit at the camps for ore carrying 65 per cent WO_3, effective Feb. 1, 1918. The output for 1915 and 1916 was also figured at 50s., though this price is probably high.

Wolframite has been mined at Hatches Creek, 800 miles southeast of Darwin, and at Wauchope Creek, 80 miles west of Hatches Creek. Both are in the Davenport ranges. It is also obtained from Burn's mine, 40 miles east of Pine Creek, and from Yenberrie, in the same district.

New South Wales.—1917: New South Wales Dept. Mines Ann. Rept. for 1917, p. 3, 1918. Figures as given: Wolfram, 118.23 long tons; scheelite, 126.56 long tons. The ore is considered as carrying 65 per cent WO_3.

1918: New South Wales Dept. Mines Ann. Rept. for 1918, pp. 57–61. The scheelite produced amounted to 117.12 long tons, valued at £21,078, and the wolframite to 136.41 long tons, valued at £24,552. Considered as carrying 65 per cent WO_3. Of the scheelite, 63.75 tons, valued at £12,000, came from the Hillgrove Division. The report does not account for the remainder. The Damifino Syndicate, in Bakers Creek Gorge, was the largest producer. With 14 men employed, 98 tons of ore was mined. It was hand picked, and the high-grade pieces were bagged. The second-grade ore was broken by hand, crushed by hand rolls, and then concentrated in hand jigs. The 98 tons gave 18 tons of scheelite, valued at £3,613. The Rockvale Wolfram Mines, at Tungsten, was the largest producer of wolframite and employed not less than 23 men. The machinery on the mine is valued at £12,000. This company during 1918 obtained from its open cuts, etc., 2,739 [long] tons of lodestuff, which, when crushed and concentrated, gave a yield of 30 tons 5 hundredweight of wolfram concentrates, valued at £5,445. The principal workings were on Carter's lode, which is said to be from 8 to 17 feet wide and to average about 12 feet wide, with an average content of about 2 per cent (WO_3?).

Tasmania.—1917 and 1918: Tasmania Sec. Mines Repts., 1917 and 1918, pp. 47, 51 (in each report). In 1917 the production of wolframite was 172.19 long tons, valued at £28,714, and of scheelite 69 tons, valued at £39,252. The material is considered as carrying 70 per cent WO_3. According to the report for 1917, page 36, "perhaps the most important active wolfram mine in the island is that at Storys Creek, Ben Lomond. It has a magnetic separation plant on the spot which treats the tin-wolfram ore of this mine. The fortnightly output is about 5 tons of wolfram, averaging 73 per cent, and 1½ tons of tin ore." The scheelite all comes from contact-metamorphic deposits on King Island, in Bass Strait, between Tasmania and Australia, 60 miles northwest of the Tasmanian coast. The mine made its first production, which was also the first production of scheelite in Tasmania, in 1917. In that year 4,937 long tons of ore gave 69 tons of concentrates carrying about 70 per cent WO_3, and valued at £12,130. Sixty men were employed. In 1918 a steam shovel was used in handling ore and 21,088 long tons gave 216 tons of concentrates carrying 70 per cent of WO_3, valued at £39,253 16s. 6d. These figures show a yield of 0.717 per cent of WO_3. Working costs were 11s. 10d. per ton of ore.

New Zealand.—1917: MacDonald, W. D. S. (New Zealand Minister of Mines), mines statement for 1917, page 19, chapter 2, Wellington, 1918: "The quantity of tungsten-ore concentrate obtained during the year was 199.4 [long] tons (value, £37,863) as the result of treating 19,655 tons of scheelite-bearing quartz, from which gold to the value of £8,098 was also obtained." Of the ore, 161 tons, valued at £28,972, was exported.

1918: Fraser, Sir William, same report for 1918, pages 20–21. During the year 143.3 long tons of scheelite concentrates, valued at £31,279, were made from 15,098 tons of ore, and 169.5 tons of concentrates, valued at £37,922, were exported. The Glenorchy Scheelite Co. at Glenorchy, Lake County, Otago, was the largest producer and made 65 tons of concentrates, valued at £14,365, from 1,059 tons of ore. The next largest producer was the Dominion Consolidated Co. at Wakamarina, Marlborough, which obtained 23 tons of concentrates from 11,973 tons of ore. The remainder of the output was divided among 36 mines. The tungsten mineral is all scheelite. The ores carry some gold; the ore at Glenorchy is said to carry 12 shillings per long ton and the concentrates to average 70 per cent WO_3. (Gudgeon, C. W., The scheelite-gold mines of Otago, New Zealand: Australian Inst. Min. Eng. Proc., ser. 21, pp. 38–50, 1916.)

Chile.—Anuario estadístico de la República de Chile, Minería y metalurgía, año 1917, pages 1, 2, 11, Santiago, 1919. The report gives the production of tungsten ores during the last 10 years as follows: 1908–1914, none; 1915, 8,560 kilograms=10 short tons; 1916, 2,332 kilograms=3 short tons; 1917, none. Wolframite.

Argentina.—Direccíon general de minas, geología é hidrología Bol. 2, series A (Minas), Buenos Aires, 1910, and succeeding numbers, except the figures for

1909, which are taken from the Anales of the same bureau, volume 6, No. 3, page 179a. Further details are given below:

Year.	Concentrates (metric tons).	Content of WO_3 (metric tons).	Average percentage of WO_3.	Equivalent in material carrying 60 per cent WO_3 (metric tons).	Value (gold pesos).[a]	Remarks.
1909	753.7	471	[b] 63.5	[b] 785	....	The content of WO_3 ranged from 43 to 72 per cent. All shipped to Germany.
1910	708.566	449.400	63.4	749	399,966	
1911	583.820	371.882	63.7	620	239,737	Shipped to Germany.
1912	637.170	409.984	64.4	683	330,447	Do.
1913	535.745	344.879	64.4	575	289,698	Do.
1914	409.080	262.127	64.1	437	220,186	All went to Germany except 2 tons to England.
1915	180.649	101.509	56.2	169	305,832	Four tons to England, rest to United States.
1916	798.694	512.605	64.2	854	[b] 1,051,577	Nearly all to United States. WO_3 from 65.2 to 79.85 per cent.
1917	985	[b] 633.4	[b] 64.3	[b] 1,056	846,241	
1918	572	[b] 367.8	[b] 64.3	[b] 613	561,151	

[a] The gold peso is worth 96.48 cents in United States gold.

[b] Estimated. The per cent of WO_3 in the 1909 output (the first the Argentine Government published) was given as 70, but in the light of later shipments this seems too high and has been changed to the average of later figures.

The Argentine ores are mostly wolframite, but include some scheelite.

Bolivia.—Dirección del ramo. Revista de aduanas de Bolivia. Organ oficial, La Paz, February 16, 1919, page 4. The exports, which are practically the same as the production, are given as follows:

Year.	Quantity (kilograms 65 per cent WO_3).	Value (bolivianos).[a]
1913	282,597	415,417.59
1914	276,316	428,300.10
1915	792,511	1,497,845.80
1916	3,035,134	5,675,700.58
1917	3,890,534	10,810,291.67
1918	3,418,359	10,640,392.49

[a] The boliviano has varied in value considerably during the period represented by these figures but may be taken as roughly one-third of a dollar in United States gold.

Peru.—1917: Jimenez, C. P., Estadística minera en 1917. Cuerpo Ing. Minas Perú, Bol. 95, p. 227, Lima, 1919. Production, 406.3 metric tons, valued at 104,349 libras ($507,814), averaging 63 per cent WO_3. Of the total, Ancachs produced 243.3 tons, Libertad 161.8 tons, and Huancavelica 1.2 tons.

1918: Handley, W. H. (United States consul general), Commerce Reports, Sept. 22, 1919, p. 1527. The following table gives the total exportation of tungsten from all Peruvian ports to New York during the calendar year 1918, showing the points of shipment, quantity, and net value. The mineral shown as shipped from Callao originally came from the port of Chimbote:

Port of shipment.	Gross weight (kilos).	Net weight (kilos).	Tungsten[a] contained (kilos).	Commercial value.	Freight.	Net value.
Salaverry	178,959	176,487	109,860.6	$243,812	$19,742	$224,070
Chimbote	55,669	54,885	33,439.2	74,206	4,102	70,104
Callao	11,030	10,780	7,478.2	16,595	907	15,688
	245,658	242,152	150,778.0	334,613	24,751	309,862

[a] This evidently should be "tungsten trioxide (WO_3) contained." The ore averages 61.4 per cent WO_3.

Mexico.—Figures of imports into the United States.

Canada.—McLeish, John, The mineral production of Canada during the calendar year 1918, page 44, Ottawa, Mines Branch, 1919. The production was 13.5 short tons of ore (scheelite), carrying 19,915 pounds of WO_3, mostly from the Acadia Tungsten Mines (Ltd.), Burnt Hill, New Brunswick.

Norway.—Statistiske Centralbyra Norges bergverksdrift, Norges Officielle Statistik, Kristiania. Wolframite and a little scheelite are mined with molybdenite in the vicinity of Stavanger. The output for 1917 came from the Hovlands farm, Orsdal in Bjerkreim parish, and was mined by the Christiania Minekompani. From 297.6 cubic meters [of ore?] was obtained by hand crushing and hand washing 1,496 kilograms of concentrates carrying 7.03 per cent MoS_2 and 1,371 kilograms carrying 40 per cent WO_3.

Sweden.—1918: Sveriges Officiella Statistik. Bergshantering Berättelse för År 1918, av Kommerskollegium, pages 96–97, Stockholm, 1919. The first Swedish production of tungsten ore was made in 1918. From the Södra Yxsjögruven, Örebro län, 861 tons of ore gave 3.81 metric tons of concentrates carrying 50 per cent WO_3.

England.—Home Office, Mines and quarries; general report, with statistics, pt. 3, for various years, London.

Year.	Quantity (long tons).	Content of WO_3 (per cent).[a]	Value.
1913	182	[b] 64	[c] £17,709
1914	205	64	19,722
1915	332	64	44,903
1916	394	61	49,699
1917	231	62.75	39,742
1918	302	60.2	49,215

[a] The percentage is given in the report only for the Cornish output, which is by far the largest quantity. No value is given for the 1913 output, and it is taken as the same per ton as that of 1914.

[b] Estimated.

[c] The value of 2.5 tons from Devon is estimated.

France.—Direction des mines, Ministère des travaux publics, Statistique de l'industrie minérale et des appareils à vapeur pour l'année 1913, p. 115. The production for 1913 is given as 1,073 metric tons carrying 762 tons of metallic tungsten. This is evidently a mistake, as it would mean 961 tons of WO_3, or 1,601 tons of ore carrying 60 per cent WO_3. There should probably be a decimal point before the 2, making 76.2 tons of metal, equivalent to 160 tons of concentrates, which is consistent with other years.

1914–1918: Direction des mines, Ministère des travaux publics, Statistique de l'industrie minérale et des appareils à vapeur pour les années 1914–1918, p. 125, Paris, 1919. The production in 1918 was from Les Montmins, Allier; Montbelleux, Ille-et-Vilaine; Cantal; Puy-les-Vignes and Vaulry et Cieux, Haute-Vienne. The production from 1914 to 1918 was as follows:

Year.	Ore (metric tons).	Metal contained (metric tons).	
		W.	Sn.
1914	12,718	69	....
1915	6,062	60	....
1916	7,289	77	11
1917	8,548	124	24
1918	7,414	101	7

Portugal.—1917: Lowrie, W. L. (American consul general), Portugal's production and exports of tungsten: Commerce Repts., Mar. 16, 1918, p. 996. Quotes official statistics stating that the exports of ore had been as follows: 1915, 860.7 metric tons; 1916, 1,308.5 tons; 1917, 145.7 tons. The usual run of ore is said to carry 65 per cent WO_3. Engineers acquainted with the country believe that enough ore was smuggled out of the country in 1916 and 1917 to raise the total to 2,000 tons for each year.

1918: Estimated.

Spain.—1917: Consejo de minería, Estadística minera de España, año 1917, p. 39, Madrid, 1918.

Province.	Quantity (toneladas).	Value at the mine (pesetas).	Average percentage of WO_3.	Equivalent in material carrying 60 per cent of WO_3 (toneladas).
Badajoz	142	781,000	58	137.3
Cáceres	34	42,000	30	17
Córdoba	40	13,560	5	3.3
Coruña	39.3	57,900	30-50	26.2
Orense	68.5	143,500	45-50	54.2
Pontevedra	138.3	295,750	50-60	126.8
Salamanca	79	301,899	58	76.4
Zamora	4.8	8,675	58	4.6
	545.9	1,644,284	....	445.8

The tonelada is a metric ton; the peseta is equal to 19.3 cents.

1918: Consejo de minería, Estadística minera de España, año 1918, pp. 39, 130, 152, 205–206, 365–373, 402–405, 407–413, 453–454, Madrid, 1919. As given (p. 39) the figures are:

Province.	Quantity (toneladas).	Value at the mine (pesetas).	Average percentage of WO_3.	Equivalent in material carrying 60 per cent of WO_3 (toneladas).
Badajoz	210	1,260,000	58	203
Cáceres [a]	151	302,000	45-50	118
Córdoba	50	25,000	5 WO_3 12 Cu	4
Coruña [a]	14.930	30,446	50-60	14
Orense	138	280,000	45-50	106
Pontevedra	129	511,046	50-60	118
Salamanca	12.242	40,790	58	12
Zamora	[b] 3.850	8,075	58	4
	709	2,457,357	....	579

[a] Part of the production is from tin mines.

[b] In the original table the quantity has been set three places too far to the left, so that it reads as 3,850 toneladas, but by reference to the value, repeated in the provincial report (p. 453), the error is evident.

Italy.—1917: Inspetterato generale delle miniere, Rivista del servizio minerario nel 1917, pt. 1, p. 62, 1918. "Minerali di tunsteno, 1.2 tonnellate."

Germany.—Montanistische Rundschau, Vienna, February, 1916, page 92. The Saxon output of ore (wolframite) is given as 96 metric tons in 1913 and 108 tons in 1914. The Vierteljahrshefte zur Statistik des Deutschen Reichs for 1916 gives the following figures of production:

Year.	Mines.	Workmen.	Tungsten ore.	
			Quantity (metric tons).	Value (thousands of marks).
1913	3	148	15,833	181
1914	3	187	25,736	176
1915	4	192	45,825	749
1916	5	324	82,495	813

If these figures represent the raw ore from which concentrates given in the Montanistische Rundschau were made, the percentage of concentrates was 0.004 in 1914, and the outputs for 1915 and 1916 have been estimated on that basis because no more reliable figures are at hand. The output for 1917 and 1918 is estimated.

Austria.—Oesterreichisches Statistisches Handbuch, 1916–17, Vienna, 1918. The ore mineral is wolframite and is from Bohemia. The content of WO_3 is not given. The outputs for 1916–1918 are estimated.

Russia.—Tredwell, R. C. (American consul at Petrograd), reported to Secretary of State, December 22, 1917: "About 2,000 poods, or 72,200 pounds of tungsten concentrates were produced [in 1916], the value of which is not given. The total amount was used in Russia." There are small deposits in the Ural region at Baevka, Perm, and a number of small deposits in the mountains east of Lake Baikal. Small quantities have been mined, but there are no known accurate records. Statistics for later years are estimated. The Siberian deposits might well be put in a Province of their own, and, of course, do not belong with the European Provinces, but they are so small that for convenience they are included in the Russian output.

South Africa.—Southern Rhodesia: Reports of the Secretary of Mines for 1906 to 1918, Salisbury. The reports give the following figures for the output of wolframite concentrates:

Year.	Weight (short tons).	Value.	Year.	Weight (short tons).	Value.
1906	18	£1,619	1912	1	£100
1907	50	4,312	1913	4	427
		1,149	1914	None.	None.
1908	31	2,165	1915	None.	None.
1909	14	1,190	1916	2.5	466
1911	2	167	1917	11	2,070

All was wolframite except 38 tons in 1907 and 2 tons in 1911.

Union of South Africa: Thirteenth annual statement of the trade and shipping of the Union of South Africa and of Southern and Northern Rhodesia, 1919, Capetown, 1920. Exports from the Union of South Africa: 1917, 13 short tons, valued at £1,174; 1918, 37 tons, valued at £5,613. From Southern Rhodesia: 1918, 37 tons, valued at £5,304. These two items of 37 tons are thought to be probably the same.

DEVELOPMENTS AND CHANGES IN GEOGRAPHIC DISTRIBUTION IN THE NEAR FUTURE.

The increase in the output of tungsten ore from eastern Asia has been marvelous. In 1913 it amounted to 2,604 metric tons (2,870 short tons), and in 1918, as already stated, to 18,303 metric tons (20,175 short tons)—more than 57 per cent of the world's production. As in other parts of the world, production must decrease until the accumulated stocks in the reducing centers are used, then production will again proceed as it has in the last few years. The alluvial deposits of China are by no means exhausted; the veins are scarcely touched; the tungsten-bearing area is large and only partly prospected; the prospecting has thus far been almost wholly for placers; labor is cheap, and a large future output is sure. Although proceeding slowly, more liberal ideas of trade and government are taking root in China; educated Chinese or trained foreigners will in time work the deposits, and the output will be large for a long time, though it may never again be as large as it was in 1918.

So far as can be learned, the easily worked placers of Burma and the upper parts of the veins are rapidly becoming exhausted,[1] and recourse must therefore be had in the future more and more to the mining of those parts of the veins that lie below water level and in harder rock, and this will probably mean a diminution rather than an increase in output. Siam seems to be a country which should give an increased production, as the mines are comparatively new, and there still should be opportunity for discoveries. The Federated Malay States and the Unfederated States—Johore, Kedah, and Trengganu—should produce at least as much in the immediate future as in the past, given the demand and an equal price.

Like other British possessions, Australia labored under the handicap of a comparatively low fixed price for tungsten ores during the war. This price, at first 55 shillings per long ton unit c. i. f. London, was later raised to 60 shillings. The price paid in Australia during the earlier part of the war averaged less than half the price paid in the United States, and only a little more than half that paid in other regions outside of the British Provinces. The result has been that the Australian tungsten production did not increase as it might have done during the war had prices been higher. However, the cream of the known deposits is gone except in Tasmania, where contact-metamorphic deposits on King Island have quadrupled the Tasmanian output. The principal tungsten mineral produced in Australia is wolframite, with smaller quantities of huebnerite and scheelite. The huebnerite is apparently rarely recognized as such in the British market, but is all sold as wolframite. Except for the contact-metamorphic deposits on King Island, the deposits worked in Tasmania are mostly veins, with some pegmatites.

In New Zealand the product is wholly scheelite. The output increased considerably during the war until 1918, when, apparently owing to a lack of efficient labor, it fell to the lowest point since 1909. The probabilities are that there will be a cessation of output for the present.

The increase in the production of tungsten in Bolivia has been very great. The deposits seem to be wholly veins and derived placers. The veins are closely connected with the tin deposits, and tin and tungsten are frequently found in the same veins; but many tungsten deposits contain little or no tin. The tungsten minerals mined are ferberite, wolframite, scheelite, and some huebnerite, mixed in some veins and wholly separate in others. The mines occur in and on both sides of the eastern Cordillera of the Andes through a distance of nearly 400 miles, from a point near Puerta Acosta on the northwest to Chorolque on the southeast. Prices for mining during the war rose greatly, in sympathy with the rise in other parts of the world. Wages did not rise to great heights, but the cost of materials increased very much. Transportation conditions are always bad in most of Bolivia and heavily increase expenses. These circumstances cause great sensitiveness to a decrease in demand or prices, and the output from Bolivia fell quickly after the signing of the armistice, but should high prices return the output will probably again increase quickly. Some modern plants were placed at mines before or just as the armistice was signed, and when world stocks of tungsten are used and there is again a demand, some ore will be produced even at less than $6 a unit, though the average cost has been reported to be about $12 a unit at the mine.[1]

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[1] Burma Chamber of Commerce and Tavoy Chamber of Mines, Memorial to Sir George Barnes; Min. Jour. (London), vol. 121, p. 261, May 4, 1918.

The Peruvian output as now produced is apparently dependent upon high prices and could probably remain at the level of 1916 for several years if prices were sufficient. The Huaura deposits are reported to be large, though of low grade, and may under proper management yield largely even at lower prices. They have been under the control of German firms during the war and probably still are.

Until 1912 the United States was the leading tungsten producing country. In that year it was passed by Burma, which kept the lead until 1916, when the United States again became the principal miner of tungsten ore, but in 1918 China came into the high-priced market with a production that exceeded by nearly 1,000 short tons the world's production in any year before 1915. North America increased its output from 1,549 short tons (1,405 metric tons) in 1913 to 6,483 short tons (5,882 metric tons) in 1917, but it dropped back nearly 1,000 tons in 1918 to 5,341 short tons (4,845 metric tons). The decrease of production in the United States was due almost wholly to the fall in price and only partly to exhaustion of deposits. Although in the Boulder tungsten field some of the best deposits have been exhausted and the cost of production has become very much greater owing to the impoverishment of others, and the same thing is true in some other places, it seems possible that owing to the discovery of the contact-metamorphic deposits of the Great Basin, the production of the country as a whole can temporarily be made about equal to the largest made before, provided prices are as high as in that period.

In Mexico the tungsten deposits are apparently a continuation of those of southern Arizona. So far as known, all the Mexican deposits carry scheelite, in places partly replaced by cuprotungstite. The known worked deposits are in the Sahuaripa district of Sonora and are described as veins in which scheelite is found with copper minerals and pegmatites in which large masses of scheelite and molybdenite occur.

European production of tungsten ores increased more than 40 per cent between 1913 and 1918, but was less in 1918 than in 1917. Portugal was the largest producer. The deposits exploited have been both placers and veins, and there seems to be still placer material to be worked, as well as the veins, which are said to be far from exhausted. The official statistics of production given by Portugal during the greater part of the war are declared by engineers conversant with the situation to have been below the facts, owing to the smuggling of ore into Spain and on board ships bound for England. On the other hand, in 1918 objection was made by England and France to the shipment of Portuguese ore to the United States, but they would not pay prices equivalent to those offered in this country. The Portuguese Government therefore issued an order preventing the shipment of tungsten ore from the country except at fixed prices approaching the current American prices. American owners of mines in Portugal could not operate their mines successfully under the British-French embargo, with the result that the total Portuguese output was probably a good deal smaller than in 1917. In spite of the uncertainties, the official estimates have been used as far as they are available because no better figures are at hand.

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[1] Hazeltine, Ross, United States consul, La Paz, report dated May 14, 1919.

As to the Spanish output it is difficult to prophesy the future, because the data concerning the mines are meager.

It seems probable that, under similar prices, the English and French deposits will make about the same output in the future as in the past. The English output decreased in 1917 and rose only a little in 1918, in spite of the British Government's interest in a larger quantity of concentrates. No accurate data are available from France. The German and Austrian deposits were probably worked so hard during the great war that less is to be expected from them than they have heretofore produced.

The principal changes in the distribution of production to be expected during the next few years would seem to be further development of veins and contact-metamorphic deposits in Chosen, the possible development of veins in Manchuria, the development of new placers and veins in southern China and Siam, the development of both veins and placers in Bolivia, a tendency in the United States to largely increased production from the contact-metamorphic deposits of the Great Basin, and the development of both veins and contact-metamorphic deposits in Mexico. There will possibly be a decrease in production from the Atolia and Boulder fields of the United States and also from Australia, Japan, Germany, and Austria.

POLITICAL AND COMMERCIAL CONTROL.

The actual control of the world's tungsten deposits differs considerably from that indicated by the production within political boundaries. Actual control may be obtained through ordinary competitive purchase, through ownership of deposits by nationals or by governments, and through commercial alliances. Control may also be had through ownership of banks and lines of transportation and through political pressure.

Owing to the close relations between foreign Governments and private firms, as illustrated by the German Government's interest in dye, potash, and shipping firms and by the British Government's participation in nickel-mining and ferrotungsten-making companies, it is not practicable to separate entirely governmentally and privately controlled deposits. Under the weaker governments foreign deposits owned by British subjects are to all intents and purposes British, but owing to the difference in national laws and policies foreign deposits owned by Americans are rarely or never under American political control.

The following table practically shows only where the ores of various countries went for treatment during the last two years of the World War and is, of course, only a generalization, and the movements it indicates are likely to have changed while it was being compiled, for trade conditions change constantly and rapidly. For instance, Japanese electric furnaces are beginning to smelt tungsten ores, though at present only to the extent of 10 or 15 tons of contained tungsten a month, but it is conceivable that the output may soon be greatly increased. In the table Japan is given credit for control only of its smelted ores, though it could control the disposition of all its ore. Again, it is impossible to divide the ores from a number of the countries properly among their customers. Other weaknesses inherent to most statistical studies are also present in this table, which is therefore given as approximate only, although it is thought to furnish instructive data.

Approximate actual control of the world's output of tungsten ore in 1917 and 1918.

Control.	1917		1918	
	Quantity (metric tons).	Percentage of world's output.	Quantity (metric tons).	Percentage of world's output.
British:				
From possessions:				
Burma (including Shan States)	4,226	....	4,138	....
Unfederated Malay States	334	....	1,156	....
Federated Malay States	721	....	362	....
India	68	....	44	....
Australia	1,277	....	1,351	....
New Zealand	235	....	170	....
England	245	....	308	....
South Africa	12	....	34	....
	7,118	27.9	7,563	23.7
Obtained through trade and political influence (includes some ores for France)	5,436	21.3	3,185	10.0
Total ores under British control	12,554	49.2	10,748	33.7
French (France, Tonkin, Portugal, Bolivia [see British], Argentina [see British])	1,292	5.1	1,145	3.6
German (Germany, Austria, Norway, Portugal, Spain)	317	1.2	317	1.0
American (Canada, Mexico, Peru, Bolivia, and Argentina,) Japan and Chosen (including some Chinese ore), China and Hongkong, Portugal, Siam (domestic production)	11,113	43.5	19,655	61.7
Miscellaneous	217	1.0	....	....
Grand total	25,523	100.0	31,865	100.0

BRITISH CONTROL.

Canada.—The British Government during the war demanded and obtained all the tungsten ores produced in its colonies and possessions. This restriction was later withdrawn as applied to Canada, and the new rule allowed Canada to ship tungsten ores to other Entente nations; but as Canada was a very small producer the permission granted amounted to little, except as it made a better feeling among Canadians. Scheelite deposits had been discovered in Manitoba that for a time seemed to be potential producers.

Siam.—Nominally most of Siam has remained free from British control because it was more or less under the zone of influence of the French. The Siamese ores usually contain some tin and have gone to Singapore for separation, and when once within the British possessions, of course, the ores could not be shipped out without permission. However, the British control of Siamese shipments is apparently as complete as if they came from a British province. Mr.

Nassuer, of the Siamese American Trading Co., testified before the Tariff Commission at San Francisco, June 28, 1918, that his company wished to ship ore to the United States but that the British minister to Siam would give no permit. The company took the matter up through our Department of State and finally got permission to ship 10 short tons. In February, 1918, the Chemical Products Co., of Washington, D. C., protested to the Department of State at Washington with reference to British interference with exportation of tungsten ore from Siam to the United States, stating that the company was under conditions peculiar to itself in that it was operating an expensive process developed to handle low-grade ores obtainable at a much lower price than regular grades on the market; that it had entered into an agreement with an American citizen who was operating tungsten mines in Siam covering the purchase of his tungsten ore only to find that through control of port privileges at Singapore and Hongkong the British effectually prohibited it or any other American firm from obtaining the material. Doubtless no such objection would now be offered, but the incidents cited show the efficiency of these methods of controlling commerce when it is thought advisable.

China.—In southern China, as Hongkong is the port for Kwangtung and Kwangsi and parts of southern Kiangsi and Hunan, the British for a while exercised control over the export of ores produced in those districts,[1] refusing to allow the reshipment of ores unless they were sent to Great Britain.

Burma and neighboring provinces.—In Burma, in the Federated and Unfederated Malay States, and in Australia—territory that produces nearly all the tungsten ores of the British Empire—foreigners, including Americans, are not allowed to own mining property.

Argentina.—In Argentina small tungsten mines are owned by English companies.[2]

Bolivia.—The American banking interests represented in Bolivia are apparently unwilling to advance money on ore shipments, but it is reported that German and British representatives advance as much as 80 per cent of the market value of the ores shipped. This is good business. Mining corporations are also controlled by British firms, and of course the material they produce is shipped to England, it being difficult, if not impossible, for American buyers to compete for the product. Such a firm is the Aramayo Francke Mines (Ltd.), which produced 2,050 long tons (2,296 short tons) of tin concentrates, 226.75 long tons (253.96 short tons) of wolframite concentrates, and a considerable output of bismuth, said to be 30 to 35 long tons a month, in the year ending May 31, 1916.

Portugal.—In Portugal a number of the mines are controlled by English companies, among which the Thermo Electric Ore Production Corporation (Ltd.), seems to be the largest owner.

Dutch East Indies.—In the Dutch East Indies the British are understood to have control at present of the wolframite production, which, however, is comparatively small, not more than 5 short tons a month.

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[1] Anderson, G. E., American consul general, Hongkong, China, Tungsten from South China: Commerce Repts., Nov. 9, 1917, p. 546.

[2] Sharp, R. C., Wolfram deposits in the Argentine: Min. Mag. (London), vol. 18, pp. 230–233, May, 1918.

FRENCH CONTROL.

French control of tungsten deposits is not large. It covers the ore produced in France and in Tonkin, a part of that produced in Portugal, and a comparatively small part of that produced in Argentina and Bolivia. The French Government leased several tungsten mines a day's journey east of La Paz, Bolivia, from Easley & Inslee, but the output was not large.

During the war control in Portugal was attempted by Great Britain and France. The prices offered by the British and French were much below the market prices in New York, and the Portuguese Government stepped in and raised prices to a point somewhat lower than those in the United States but 20 per cent higher than the prices offered by England and France.

JAPANESE CONTROL.

Japan has within her own borders, in the southern part of the islands, a considerable number of tungsten deposits, but all are small. In Chosen (Korea) valuable deposits have been discovered and actively worked, especially within the last two years. Deposits in Manchuria are also said to be controlled by the Japanese, but little is known of them, and if they exist they are probably small. A part of the ore from southern China has also been handled by the Japanese.

Japanese ores have largely come to the United States for several years. As has been said, Japanese firms have erected electric furnaces in which a part of the tungsten ores are reduced, probably the equivalent of 25 to 35 short tons a month of concentrates carrying 60 per cent of WO_3.

AMERICAN CONTROL.

The United States controls entirely the tungsten deposits within its own borders and Alaska.

Mexico.—Americans operating in Mexico have produced 150 to 250 short tons of scheelite concentrates annually from deposits in the Sahuaripa district, Sonora. Wolframite has been shipped from Sinaloa to the United States, but its real origin is unknown. Contact-metamorphic deposits carrying 0.7 per cent of WO_3 and 1 to 2 per cent of copper have been found about 60 miles southwest of Nacozari and are owned by Americans but are not now productive.

Bolivia.—In Bolivia Americans own some of the more important tungsten mines. The American firms known to own tungsten properties in Bolivia are W. R. Grace & Co., local address, La Paz; Stewart, Wilson & Hepburn, Oruro; Easley & Inslee, La Paz; and C. Dillon, Oruro. Their total output was estimated to amount in 1918 to about 1,600 short tons out of a total output of more than 4,000 short tons (3,703 metric tons) for the country.

China.—In southern China, as already noted, American firms have largely worked up the tungsten trade, so that through this source the United States controls (or more properly speaking Americans control, unless interfered with) a trade possibly amounting to 9,000 short tons of tungsten concentrates a year.

Siam.—In Siam one or two American companies have attempted to produce tungsten, but, as noted, British influence during the war made it difficult to ship even very small lots of ores to this country.

Japan.—The United States largely controlled the Japanese output of tungsten ore in 1918 because it offered higher prices than other countries and because its trade route was more direct and shorter, so that it was to the advantage of the Japanese to trade with this country. This trade probably has been already somewhat curtailed and will be further curtailed through the erection of electric furnaces in Japan.

Imports.—The following table shows the tungsten ores imported into the United States in 1918, but such a table gives a poor idea of the ores shipped from the countries of origin during the year. Thus Chinese ores lag three months and South American ores about two months. The table gives only the ores actually received during the year. The table of control (p. 1006) gives more nearly the ores shipped to the United States during the year.

Tungsten-bearing ore imported into the United States in 1918.

[General imports.]

Country.	January.		February.		March.		April.		May.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Argentina	35	$49,797	56	$67,507	22	$30,549	68	$94,060	22	$34,598
Bolivia					28	37,500				
Brazil										
Canada							12	36,000		
Chile	289	210,392	90	92,904	14	13,241	91	94,037	76	69,440
China	13	9,585	108	73,557			116	132,659	312	253,786
Costa Rica									18	19,081
Ecuador									6	9,979
France										
Hongkong				30		15	126	106,414		
Japan	146	170,531	109	157,705	88	87,616	88	112,366	74	64,066
Mexico	50	39,000			18	5,224	40	32,490	61	50,800
Other British East Indies			19	13,071						
Panama					2	1,815	21	21,294		
Peru	301	135,444	158	107,449	129	96,202	118	101,975	209	220,469
Portugal					17	10,351	10	7,409		
Salvador										
Siam									11	8,583
	834	614,749	540	512,223	318	282,513	690	738,704	789	730,802

Country.	June.		July.		August.		September.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Argentina	24	$32,801	78	$103,684	6	$7,500	39	$55,881
Canada							44	79,863
Chile	126	156,705	20	29,400	128	127,541	30	21,844
China	142	138,946	432	353,517	161	146,492	168	137,488
Colombia			17	22,424				
France	29	3,400						
Hongkong	112	86,963	128	126,987	185	190,279	703	749,299
Japan	36	31,422	134	145,184	130	191,562	110	163,456
Mexico	30	27,000	25	22,187	5	5,060	1	1,226
Other British East Indies								
Panama			14	17,505				
Peru	236	202,408	113	108,009	38	42,635	175	121,008
Portugal								
Salvador								
	735	679,645	961	928,897	653	711,669	1,270	1,330,065

Tungsten-bearing ore imported into the United States in 1918—Continued.

Country.	October.		November.		December.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Argentina	105	$145,717	34	$42,385	47	$66,243	536	$730,722
Bolivia			32	51,032	28	33,825	88	122,357
Brazil	3	4,177					3	4,177
Canada							56	115,863
Chile	68	72,511	206	188,324	112	133,525	1,250	1,209,864
China	255	222,522	405	341,364	273	258,720	2,385	2,068,636
Colombia					39	42,700	56	65,124
Costa Rica							18	19,081
Ecuador							6	9,979
France							29	3,400
Hongkong	445	450,901	1,307	1,228,707	589	571,451	3,595	3,511,046
Japan	73	65,328	360	492,878	14	18,218	1,362	1,700,332
Mexico	17	22,820	12	12,000	5	6,440	264	224,247
Other British East Indies							19	13,071
Panama							37	40,614
Peru	108	108,272	192	191,198	50	53,447	1,827	1,488,516
Portugal							27	17,760
Salvador			40	60,042			40	60,042
Siam							11	8,583
	1,074	1,092,248	2,588	2,607,930	1,157	1,184,569	11,609	11,413,414

Tungsten-bearing ore imported into the United States, 1916–1918.

[General imports.]

Country.	1916		1917		1918	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Argentina	641	$1,442,569	217	$244,793	536	$730,722
Bolivia	60	171,420	45	45,042	88	122,357
Brazil	6	4,031			3	4,177
British Guiana	22	44,700				
British South Africa			1	1,100		
Canada		100			56	115,863
Chile	1,183	2,750,364	1,930	1,808,853	1,250	1,209,864
China	21	21,881	195	136,268	2,385	2,068,636
Colombia					56	65,124
Costa Rica					18	19,081
Ecuador			12	7,880	6	9,979
France	2	3,494			29	3,400
Hongkong	7	13,662	33	20,994	3,595	3,511,046
Japan	594	1,041,570	601	622,691	1,362	1,700,332
Mexico	176	107,125	340	176,849	264	224,247
Other British East Indies					19	13,071
Panama	3	7,600	159	147,592	37	40,614
Peru	1,124	1,475,375	1,198	1,126,593	1,827	1,488,516
Portugal	167	212,685	120	105,830	27	17,760
Salvador					40	60,042
Siam	66	57,115	28	23,123	11	8,583
	4,072	7,353,691	4,879	4,467,608	11,609	11,413,414

The tables show that in 1918 the United States imported 11,609 short tons (10,532 metric tons), which, supposing it to carry 65 per cent of WO_3, is equivalent to 12,576 short tons (11,410 metric tons) of ore carrying 60 per cent of WO_3, or 35.8 per cent of the tungsten output of the world, and adding this to the domestic output makes a total of 17,637 short tons (16,001 metric tons), about 50.2 per cent of the world's production. Owing to the lag in shipments the South American ores received in January and February were ores produced in 1917, as were the Chinese ores arriving up to the end of March. Subtracting the ores arriving from the two regions during the first two and three months, respectively, of 1918 and adding the ores arriving during like periods in 1919 shows that the quantity of ore controlled by the United States in 1918, as indicated on page 1006, was equivalent to 19,655 metric tons of concentrates carrying 60 per cent of WO_3 and amounted to 61.7 per cent of the world's production. These ores were all controlled through the private initiative of American firms that offered better prices and better terms than could be obtained abroad.

GERMAN CONTROL.

Germany has had no considerable tungsten deposits at home and none in the foreign territory she held, but in 1913 her control of the tungsten trade through business alliances covered about two-thirds of the entire output of tungsten ore. In that year, according to the German official figures, she imported 4,780 metric tons of tungsten ores. Most of this ore probably carried 65 per cent or more of WO_3, and the total was equivalent to, say, 5,178 metric tons of concentrates carrying 60 per cent of WO_3. Adding the 96 metric tons of concentrates produced in Saxony in that year indicates that Germany treated a total of approximately 5,274 metric tons out of a world's output of 8,123 metric tons, or about 65 per cent of the total. The United States in the same year produced 1,537 short tons (1,394 metric tons) and imported 449 short tons of unknown content, but the whole was probably equivalent to more than 2,000 tons of ore carrying 60 per cent of WO_3, leaving only about 1,000 short tons for other countries, most of which seems to have been treated in France. This trade Germany lost when with Austria she started the war, and control shifted to Great Britain and the United States. With the cutting off of all shipments by ocean to Germany, most of the foreign ores were denied to her, but undoubtedly small quantities leaked in through Sweden and Norway for a considerable time after the beginning of the war. The small output of Austria was always available, and it is said that a considerable quantity of ore was smuggled across the border of Portugal into Spain, thence by water to the western frontier of Italy, into Switzerland, and thence shipped direct to Germany. A considerable part of the Spanish product is said to have reached Germany in this way also, and the "crippled" submarines that landed at Spanish ports are reported to have carried out cargoes of tungsten for Germany. From available data it is impossible to confirm or to disprove these reports, and in repeating them their doubtfulness is fully recognized, but such possibilities must also be recognized.

Bolivia.—In the Allied countries and the United States the German interests were taken over by the respective Governments, but in South America, German firms still hold some control of tungsten-bearing properties. In Bolivia four German firms are said to have an annual output of about 600 metric tons of ore.

Peru.—In Peru what is said to be the larger part of the tungsten deposits has been controlled by firms thought to be German—E. & W. Hardt and Carlos W. Weiss y Cía.

Argentina.—In Argentina the Hansa Mining Co., a German company, is the principal producer and is reported to have an annual output of about 500 short tons of concentrates. Even this firm's output is said to have come to the United States during the war.

WHAT CONTROL MEANS TO THE UNITED STATES.

The spread of knowledge, particularly concerning the operation of electric furnaces, makes the control of the tungsten trade through secret processes or superior skill very difficult, and, in view of the experience that has been gained in the United States, Great Britain, and France, such control can be only temporary. Japan is perhaps somewhat less advantageously placed than other countries. Production plants are so easily, quickly, and cheaply erected that they do not offer any great chance for monopoly. Cheap power, high technical skill and knowledge, originality and boldness in experimentation, excellence of organization, generous dealing with producers, an honest product honestly sold, good transportation facilities, and sane, broad laws are the elements that will give control. This control the United States may have with a reasonable effort.

In good business years before the great war the United States used annually an equivalent of 3,000 to 4,000 short tons of concentrates carrying 60 per cent of WO_3. When the war began there was a lull while the attacked countries caught their breath and prepared for a long struggle. After plans had been made and the manufacture of munitions began on a grand scale the demand for tungsten ores rose enormously. All kinds of ores were taken at fabulous prices. Ores carrying tin, phosphorus, sulphur, and bismuth, which before would not have been considered by steel makers, were taken with avidity, and there was a great scramble for deposits. In October, 1918, the United States was using tungsten ores at the rate of 20,000 short tons a year. Meanwhile prospecting had uncovered so many new deposits and they were so actively exploited that great stocks of ore were accumulated in the Entente countries. On the other hand, in this country many of the known deposits showed signs of impoverishment, a number which had yielded ore at a profit for a short time became idle, and it is likely that some of the deposits that have seemed to be the richest will never again produce largely. Among the new discoveries were the contact-metamorphic deposits of the Great Basin in eastern California, Nevada, and northwestern Utah. They were partly developed, and several promise well, but the irregularity of contact-metamorphic ore deposits is notorious.

Few tungsten mines in the United States can be profitably operated at the present price of less than $7 a unit, and most of the mines are now closed.

In 1916, with prices ranging from $15 to $93.50 a unit, the United States produced 5,923 short tons of concentrates; in 1917, while still under the impetus of the 1916 boom and with prices ranging about $25 a unit, 6,144 tons; and in 1918, still at a price averaging about $25 a unit for the first eleven months of the year,[1] 5,061 tons, though little was produced in December. At a price of $17 per unit, it seems improbable that the United States can depend on a production of more than 3,000 short tons a year for the next three years. There are, of course, possibilities of larger production, and there are equal possibilities that the production would be even smaller. The finding of new ores is a probability, but the quantity of ore that will be found is wholly an open question. Should another great war take place, the United States would probably begin by using tungsten at the rate of 20,000 short tons of concentrates a year, instead of gradually working up to such a consumption. Unless the price were even more extravagant than the highest price in 1916 ($93.50 a unit), the United States could not produce half of its needed concentrates, and the time required to reach even that half would be far too long for safety. Of course, such a production would be much better than none, but the United States should, for safety, have within reach at least a year's supply.

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[1] The price per unit is that for good clean ores carrying 60 per cent or more of WO_3. As a matter of fact many of the ores sold were far below grade and contained injurious impurities, so that the average price per unit for the total ore sold was about $18.30 in 1917 and $23.22 in 1918.

In view of the foregoing considerations it seems to be a fact that the United States is to-day in a position, through ownership by its people and through the influence of its trade, to keep control of the greater part of the world's output of tungsten ore and therefore control of the tungsten industry; that to accomplish this result there must be individual initiative, intelligent commercial dealing, and wise legislation; and that otherwise the tungsten industry may at any time fall back into German hands or pass under British or French control. On the other hand, should a high price for tungsten be maintained, artificially or otherwise, the development of other alloy steels for use in multiple-edged tools may reach a point at which so much tungsten will not be needed and at which the tungsten industry will therefore have lost much of its present importance.

Under any and all conditions of production, of metallurgy, of control, of legislation, and of trade one self-evident fact must be kept steadily in mind—there is only one crop of tungsten ore in all the world.

FUTURE OF TUNGSTEN MINING.

Hereafter the quantities of tungsten ore handled will be much smaller than during 1916, 1917, and 1918, and will be confined to peace-time needs unless some unforeseen war should arise. Great Britain has at present two years' supply on hand, according to Government estimates. France is probably equally well supplied. The United States at the beginning of 1918 probably had on hand a constantly increasing stock of tungsten that at that time was equivalent to 7,000 short tons of ore carrying 60 per cent of WO_3. Tool-steel makers estimate a domestic consumption of 7,500 short tons during 1919, but this is undoubtedly much too high and probably 5,000 tons is amply large, so that there will likely be little if any market for new supplies for nearly two years except as ore may be bought speculatively. During this time mines everywhere must close and remain closed until a demand again arises, except the mines required to furnish the tungsten to be taken by Germany, Austria, and Russia, and the small quantities needed by Sweden, Norway, and Italy. If Germany, Austria, and Russia recover economically so that they can buy and use tungsten, Germany will regain, in the ores that will be eagerly offered by producers needing a market, a part of the trade she has lost. Traders in England, France, and the United States will be glad to sell tungsten and ferrotungsten, but Germany will undoubtedly reach out for raw material in order that she may make as much use as possible of her abundant unemployed labor.

PUBLICATIONS.

Among the recent literature on tungsten are the following papers:

Advisory Council of Science and Industry, Australia. The manufacture and uses of ferroalloys and alloy steels, being the report of a special committee appointed to investigate the manufacture of ferroalloys and alloy steels from the raw materials occurring in Australia: Bull. No. 9, 46 pp., 10 pls., 8 figs., Melbourne, 1918.

Gives a brief history of the manufacture of ferroalloys and describes the occurrence in nature and the characteristics of manganese, chromium, tungsten, molybdenum, and vanadium; gives tables of the production of the five metals in Australia from 1915 to 1917; and briefly describes the occurrence in the different States; gives maps showing the occurrence of minerals in New South Wales and Queensland. By far the larger part of the pamphlet is given up to the description of the making of the ferroalloys in electric furnaces and the characteristics of the alloy steels.

Alleman, Gellert, and **Darling, C. J.** (Swarthmore College). Occluded gases in ferrous alloys: Franklin Inst. Jour., pp. 185, 161–198, 333–357, 461–480, 1918. Abstract by Joseph S. Hepburne in Chem. Abstracts, vol. 12, p. 1165, 1918.

A historical résumé and discussion of the literature are given in the first two instalments of this paper. In the last a description is given of the gas-tight vacuum furnace, capable of continuous service at temperatures of approximately 1,900°; the tube is made of alundum, and molybdenum wire is used for the heating element. By the use of this furnace all the gases occluded in ferrous alloys may be removed and collected. Of the occluded gases, hydrogen is most readily set free, carbon monoxide is next evolved, and nitrogen is apparently held most tenaciously. It has not been determined whether the evolved oxygen is produced by decomposition of iron oxides or by dissociation of carbon monoxide or of carbon dioxide. Ferrous alloys may occlude relatively large volumes of gases; at times the occluded gases have a volume equal to approximately 200 times the volume of the metal. The removal of the occluded gases from ferrous alloys apparently changes the microstructure and increases the density of the alloy. It is suggested that "in addition to the ordinary functions of metals like aluminum, tungsten, chromium, manganese, titanium, silicon, etc., when placed in ferrous alloys these elements may act as catalytic agents and either prevent the occlusion of large quantities of gases or aid in the elimination of such gases at lower temperatures than would ordinarily take place."

Bateman, A. M. A tungsten deposit near Fairbanks, Alaska: Econ. Geology, vol. 13, pp. 112–115, 1918.

The deposit occurs in the vicinity of a porphyritic granite in the Birch Creek schist, which consists of mica schist and crystalline limestone. The tungsten is in the form of a scheelite and is disseminated through small shoots and lenses in fine grains rarely visible except with a hand lens. Exposures of the deposit are few, but it is suggested that the deposits are a replacement of the crystalline limestone by hot solutions probably coming from the granite.

Campbell, T. M. The ore minerals of the Tavoy district; summary of a lecture at Tavoy in the summer of 1918: Min. Jour. (London), Feb. 8, 1919, pp. 82–83.

The outstanding characteristic of the ores is that they are always found in the vicinity of the contact of the granite with the overlying sedimentary rocks, in either or in both, but never at any great distance above or below the contact. Wolfram, tin, and other metals were brought toward the surface by the molten granite. Broadly speaking, the most marked peculiarity of the veins is that they usually occur in groups parallel to and close to one another, in places very numerous, very narrow, and of short length. Locally a second parallel series intersects the first. Such deposits usually end abruptly along the strike, the ground outside not being fissured or cracked. Many of the veins diminish in width and value as they go down.

Laboratory experiments show that silicon and water at high pressures and comparatively moderate temperatures, say 300° C., are miscible in all proportions and that the mixture has great solvent powers. Fluorine and boron exist in such small quantity in the veins that believers in pneumatolysis had decided that they could not have done the tin carrying at Tavoy. The existence of veins of pegmatite with coarse cassiterite or wolfram crystals can not be explained by pneumatolysis. Wolfram disseminates as a primary mineral throughout large granite masses. The Tavoy veins show practically no chlorides, little fluoride, and no tourmaline. Wolfram and cassiterite are both found in veins at least 500 feet above the surface of the granite.

Wolfram crystals may be broken, or even pulverized, the fragments being surrounded by quartz, mica, or even other ore minerals, which come in at a later stage and normally at a lower temperature. Specimens are shown of cracks in wolfram filled by cassiterite, chalcopyrite, quartz, pyrrhotite, galena, blende, mica, and bismuthinite. In the great majority of veins the wolfram was deposited before the tin (p. 83). As between wolfram and quartz the former appears to come in first invariably. There is no evidence of even simultaneous growth in the veins. Quartz generally follows cassiterite, but there are interesting examples of simultaneous growth. In the Tavoy district the succession of deposition, commencing at the highest temperature, is molybdenite; wolfram, followed by scheelite in some places and by cassiterite in others; bismuth and bismuthinite; chalcopyrite and arsenopyrite; pyrrhotite; galena; blende. Dr. Jones puts forward a theory that wolfram will give place to cassiterite at depth, but facts point in exactly the opposite direction.

Simple single crystals of wolfram are rarely seen. Wolfram has never been observed to develop in microscopic crystals which pervade the matrix but always in relatively coarse masses. Bladed, prismatic, and tabular forms are common, all striated across the prism, other forms are striated parallel to the length.

Cassiterite, commonly of the lighter shades, "black tin" being exceptional, occurs in shades from nearly water-clear to amber, brown, and deep chocolate, also in tones of gray, red, and reddish brown. Even fairly good crystals are uncommon, and none at Tavoy can be compared with those in Nigeria. Cassiterite is difficult to identify, as it exists in so many forms and colors.

Scheelite occurs more commonly than is generally supposed, because it resembles quartz and because it readily alters to tungstite. Scheelite is in places developed simultaneously with quartz, and in places later than quartz, surrounding well-developed crystals of that mineral. Secondary scheelite, not at all uncommon, rarely exhibits crystal faces.

Molybdenite, probably the first ore mineral to be deposited, is found in such small quantities and so erratically distributed that it is of little economic importance. It occurs intimately associated with wolfram and cassiterite, but appears to be characteristic of the zone at or below the bottom of the wolfram, frequently mixed with mica, lining the vein walls.

Bismuth is known in only two or three parts of the district. Sulphide of bismuth is somewhat more widely distributed though not common. It occurs in the same veins with wolfram, cassiterite, and molybdenite, commonly in contact with the two former, also associated with them as a primary mineral in granite, always fibrous, steel-gray.

Detrital deposits in the district contain rounded pebbles of wolfram with rough etched surface. Ordinary alluvial deposits contain no wolfram, though it is practically certain they did when formed and that it has been since removed.

Chemical Engineering and Mining Review. Butler's tin mine, Torrington, New South Wales: Vol. 10, pp. 265–266, 1918. Abstract by F. W. Smither in Chem. Abstracts, vol. 12, 1918.

The mine is situated in fairly rough granite country. The lode is worked by an adit level 920 feet in length and also by a shaft; the deepest point in the workings is 315 feet from the surface. The ore contains tin, tungsten, and lead, the average assay of the concentrates being tin, 53 per cent; tungsten trioxide, 12 per cent; lead, 5 per cent. Three methods of concentration are in use—table, flotation (for recovery of lead), and magnetic (for tungsten). The complete course of treatment is shown in a flow sheet. The extraction given by the wet-concentration plant, Wilfley tables, Frue and Triumph vanners, is tin 80 per cent, tungsten trioxide 67.7 per cent, lead 66 per cent. The flotation unit gives a lead extraction of 98 per cent. The magnetic separator (of the "rotor" type) gives a marketable product when working on a fairly coarse tin-tungsten concentrate, but is not comparable to the Wetherill type in dealing with the fines, owing to the retreatment required.

Cockfield, W. E. Mayo area, Yukon (tungsten deposits): Canada Geol. Survey Summary Rept., 1919, pt. B (No. 1747), pp. 10B–15B, 1918.

Describes gold placer deposits on the Cantin and Letourneau claims in which scheelite was discovered and from which very small shipments were made in 1916. In 1917 more than a ton of high-grade concentrates was shipped. Wolframite also is found in the placers. The gravel is 8 to 12 feet deep, and the pay streak is about 100 feet wide. Ground is apparently worked by groundsluicing. The gold content is from 50 to 75 cents and the scheelite 0.8 to 1.2 pounds a cubic yard after groundsluicing. About 2,500 feet in length, which contains 20 to 30 tons of concentrates, is yet to be worked. There are large quantities of tailings from which the scheelite was not saved but which probably would not pay for reworking. Panning shows scheelite on the upper part of Dublin Gulch and in Olive Gulch. The country rocks are schists, with which is interbedded some limestone, and they are cut by a boss of gray biotite granite. Quartz veins 1 to 6 inches wide cut the granite and carry from 1 to 10 per cent of tungsten trioxide. The wall rock also carries scheelite for a distance of at least 2½ feet on each side of the vein. Describes veins in the rocks adjacent to the intrusive, which are apparently contact-metamorphic deposits or at least replacements of the limestone bands. One pegmatite, a foot thick, carried scheelite, tourmaline, siderite, graphite, and wolframite (?), though not all in one locality. The scheelite is crystalline "both in the mass and lining vugs or cavites." Scheelite is also found in the placers of Johnson, Highet, and other small creeks.

Ely, O. Tungsten crystal wire as glow lamp filament: Ver. deutsch. Ing. Zeitschr., vol. 62, pp. 15–20, 1918. Abstract by Th. Verheggen in Chem. Abstracts, vol. 13, pp. 286–287, Feb. 20, 1919.

After a brief historical review of the first metallic filament used in electric incandescent lamps, the different methods of manufacturing filaments for tungsten lamps are stated. The author then describes at length a new patented process (Julius Pintsch Co., Berlin) for the manufacture of filaments made of a long crystal of metallic tungsten. "Manufacture of tungsten crystal wire: The WO_3 is pulverized as finely as possible and is completely reduced by heating in a hydrogen atmosphere to produce pure tungsten metal, a brilliant black-brownish metallic powder. To this tungsten is added a carefully determined quantity of ThO_2, [and] finally a colloidal binding material is added in very small quantities. From this doughy mass filaments of various diameters are formed. * * * After the extruded "threads" have been dried at a moderate temperature they are placed, eight at a time, into the treating apparatus, where the transformation into pure metallic crystals takes place. The treating apparatus consists essentially of a glass cylinder closed at both ends and provided with two contacts joined by a helix of heavy tungsten wire. The filaments to be treated are passed through the axis of this glowing helix by means of a simple mechanism; during the operation * * * the filaments to be treated are raised rapidly to a temperature of 2,600°–2,700°. A continuous current of reducing gas passes through the glass cylinder. * * * The speed of movement through the hot zone must be less than the speed of crystallization in order to allow the crystals to grow gradually at the expense of the small adjacent crystals. If the linear velocity of the filaments passing through the helix is too great a very fragile filament composed of several crystals is obtained * * * that breaks at the interfaces of the successive crystals. Filaments composed of a single tungsten crystal, unlike some drawn filaments, retain all their ductility and softness and resist vibration and shock even after many hours of burning; which is not the case with some drawn filaments. Comparative tests made under the same conditions with a lamp provided with a Pintsch tungsten crystal filament and lamp provided with a drawn tungsten filament have shown that after a life of 1,200 hours the filament made of a tungsten crystal had not given rise to the slightest trace of deposit on the walls of the bulb, whereas the filament of drawn wire was more or less disintegrated."

Numerous photomicrographs of the new filaments and some of the old-fashioned filaments are shown.

Foote, F. W., and Ransom, R. S., Jr. The mineral industry of Portugal: Eng. and Min. Jour., vol. 106, pp. 47–53, 1918.

Describe both alluvial and vein wolframite deposits in the Viseu, Braganza, and Arouca mining districts of Tras-os-Montes, Portugal. The mines are owned by American, British, and French companies. Little mining has been done below water level, for pyrite is found there, especially in the Braganza district, and operations are then abandoned. "Consequently there are many promising prospects waiting for sufficient capital for proper development and equipment." Give wages, cost of materials, and other details.

Granigg, B., and Koritschoner, J. J. Die turmalinführende Kupferkies-Scheelite Lagerstätte am Monte Mulatto bei Predazzo (Südtirol): Zeitschr. prakt. Geologie, pp. 481–497, 1913.

Preceded by a bibliography of the literature on tourmaline-bearing ore deposits. The Italian deposits are stringer lodes in porphyrite. The primary minerals are tourmaline, quartz, apatite, scheelite, chalcopyrite, pyrite, and arsenopyrite; the ore carries 1.5 per cent of copper. Mineralization followed the pegmatitic stage, replacing the minerals of the pegmatite. Calcite formed in final stages.

Granite, the ore bringer, contains tourmaline nodules surrounded by pegmatitic aureoles. Some of the nodules contain apatite, scheelite, fluorite, sulphides (principally chalcopyrite), galena, and calcite.

Hope, G. B. Notes on the geology of Stannary Hills, North Queensland: Australian Inst. Min. Eng. Proc., No. 31, pp. 109–119, 1918; Chem. Abstracts, vol. 13, p. 2171, Sept. 20, 1919.

Veins containing cassiterite with argentiferous galena, copper, tungsten, and antimony occur; also some small and relatively unimportant lead veins. The rocks are Paleozoic sediments (graywacke and shale), with quartz porphyry, dacite, rhyolite, and granite. Important tin deposits are of two types: (*a*) Fissure lodes in shale near igneous contracts; (*b*) irregular deposits in graywacke. Chlorite is a constant constituent of the richer ores formed from alteration of the country rock by hot solutions subsequent to the deposition of the ores.

Industrial Australian. Wolfram mines near Broken Hill: Issue of July 11, 1918, pp. 50 and 71.

A short description of comparatively small deposits.

Industrial Australian and Mining Standard. Wolfram Camp mine (Northern Territory): Issue of October 10, 1918, p. 554.

"Sixteen tons of wolfram were sent away by camel team for May, and 12½ tons for June. The Wolfram Camp mine looks well for a good future. Some say this is the best wolfram mine in Australia and that it would be difficult to find another equal to it working to-day in the world. Though it has only been worked by a few men, £100,000 worth of wolfram has been taken out of the mine. The shaft is on a high hill opposite the crushing and dressing plant. A large quantity of ore is bagged at the mine. The lower grade and that containing copper is taken to the mill and dressed up to high-grade wolfram; in the treatment it receives the copper is cleaned from the wolfram and is shipped to southern smelters. * * * A tunnel was driven into the hill to cut the lode, and after driving 400 feet the lode was revealed, showing a width of 17 feet, worth 7 per cent wolfram, and also valuable copper contents. This tunnel will facilitate the working of the mine and give over 100 feet of backs. * * * The cost of the tunnel was £700, or £7 15s. per foot, which is much lower than most of the mining done here. About £10,000 worth of wolfram has been shipped from the mine during the last 10 months."

Jannasch, Paul, and Leiste, Robert. Analysis of tungsten compounds by volatilization in a stream of carbon tetrachloride vapor: Jour. prakt. Chemie, vol. 97, pp. 141–153, 1918. Abstract by D. Breese Jones in Chem. Abstracts, vol. 13, p. 1288, 1919.

"Tungsten is separated from the bases by distillation of its chlorine compounds, which are formed by heating the tungsten compounds, in most cases to dull red heat, in a mixture of carbon tetrachloride vapor and carbon dioxide. The volatilized products are collected in dilute nitric acid, whereupon the tungsten separates quantitatively as yellow flakes of tungstic acid which can be ignited and weighed as WO_3. The ammonium and sodium salts require heating for only an hour or less. The calcium salt requires to be mixed thoroughly with potassium chloride before heating to facilitate the liberation of the tungsten chlorides from the slag of fused calcium chloride. In the analysis of lead tungstate glass wool placed in the end of the tube prevents the passage of $PbCl_2$ into the receiver. This method of determining tungsten was successfully used in the analysis of scheelite and wolframite."

Jeffries, Zay. The metallography of tungsten: Am. Inst. Min. Eng. Bull., pp. 1037–1092, 58 photo. rep., June, 1918.

Describes in a general way the reduction of tungsten from its ores; gives the melting point as 3350°C.; the making of tungsten with ThO_2 for filaments, and tungsten for other purposes. Wires below 0.03 inch in diameter are drawn hot, lubricated with aquadag. Wire 1.14 millimeters in diameter has a tensile strength of 590,000 pounds per square inch.

Jaramillio, L. B. Mining industry of Ancachos, Peru: Bol. minas ind. y construcciones (Peru), 2 ser., vol. 10, pp. 55–82; Chem. Abstracts, vol. 13, p. 2496, Oct. 20, 1919.

Gives statistics of the mineral production, together with a list of the mines and their owners, the system of exploitation used, capacity, etc.

Jensen, H. I. The Stanthorpe Ballandean district; some wolfram and molybdenite occurrences: Queensland Govt. Min. Jour., vol. 18, pp. 458–461, 3 sketch maps, 1918.

The area is in the southeastern part of Queensland, on the Southern Railway. Wolframite and molybdenite are said to be found in quartz aplite, greisen, and quartz, and in minnette [sic] dikes, which represent the mother liquor of the Sandy granites and which were injected in the final stage of the "Sandy granite." The intrusions of the Sandy granite have "octupus shapes" owing to the jointing of the hornblende and mica granite into which it is thrust. The Sandy granite is accompanied by tin, tungsten, and molybdenite in New England (New South Wales) and Queensland and in the country rock of the principal metalliferous deposits in Northern Territory. It is usually aplitic and is principally quartz and orthoclase, though it commonly carries some biotite. The "dike derivatives" are (1) quartz aplife, ranging from quartzose granite to nearly pure quartz; (2) greisen dikes, "ranging from minnette to slightly micaceous quartz." "Wolfram is generally found in the quartz aplite dikes and veins or in the quartz veins connected with the quartz aplite in origin." Molybdenite and cassiterite are more often found in the greisen. "Arsenic ore" with or without tin, copper, silver, lead, or zinc is also found in the Sandy granite.

Describes Benjamin's molybdenite mine at Stanthorpe; thinks the country rock is aplite ranging from quartz to granite, but his description suggests granite in part wholly replaced by quartz, and he calls the quartz a "pipe 40 feet in diameter." Carries 0.5 per cent MoS_2 and some bismuth.

At the Silver-Lead claim on Severn River, 6 miles west of Ballandean, is a "quartz porphyry dike passing into aplite" carrying wolframite, tin (?), molybdenite, galena, chalcopyrite, sphalerite, arsenopyrite, fluorspar, and calcite. He recognizes replacement, but apparently only in part.

Describes briefly a number of similar small deposits.

Johnstone, S. J. Tungsten within the Empire: Soc. Chem. Industry Jour., vol. 37, pp. 294R–296R, 334R–336R, 1918.

States that in quantities of 2 to 8 per cent tungsten imparts "hardness, toughness, and tensile strength to steel and so renders it suitable for the construction of armor plate, projectiles, and firearms." Before the great war England smelted little tungsten, though much ore was produced in the Empire. Germany smelted 30 to 40 per cent of the world's output. England is now making more tungsten wire than is needed by the incandescent electric lamp industry. In the soda process tungsten powder contains 98.5 per cent of tungsten (minimum 98 per cent) and 0.2 per cent of carbon. Notes that huebnerite is raised in the United States, but does not mention its occurrence in the Empire. Says scheelite "contains up to 80.6 per cent of the oxide, but it is liable to contain molybdic oxide, which is said to be very objectionable if the metal is intended for use in the manufacture of electric-lamp filaments." A little wolframite is mined in Devonshire, adjoining the Gunnislake district of Cornwall. The chief mines of Cornwall are South Crofty, East Pool, and Tincroft. The first two gave 3.6 and 2.95 pounds of wolframite concentrates per [long] ton of tin ore mined. Most Cornish tungsten ore is mined as a by-product of tin ore. A little tungsten ore is mined in Cumberland. Gives statistics for 1913 and 1916. In 1913 the ore averaged 60 per cent of WO_3 and in 1916 61 per cent of WO_3. A note from the editor says that the returns from Cornwall in 1916 probably include imported ore concentrated in Cornwall's 1917 output, really about 180 tons. In Burma wolframite has been known since 1841, but mining began in 1909. Now more than 50 mines are at work from a point 32 miles south of Tavoy to 40 miles north through a belt averaging 28 miles wide. Quartz veins contain columbite, tourmaline, molybdenite, and cassiterite. Thinks the Hermingyi mine that produced 1,000 tons of concentrates in 1917 is the largest producing tungsten mine in the world. Burmese tungsten mining is capable of considerable expansion. Gives table of production for 1913 and 1916 showing production of all India. A very little comes from Nagpur, and a little from Marwar (Rajputana) and Singhbhum (Bihar and Orissa). An editorial note says that 15 to 20 per cent should be deducted from the Burmese ore, for concentrates from the Hermingyi contain 40 per cent of WO_3 and 30 per cent of tin. One thousand tons produced in 1917 gave 570 tons 70 per cent WO_3 concentrates (equivalent to 670 tons 60 per cent).

A table is given of British tungsten production in 1913 and 1916 and the Mineral Industry's world estimate.

Queensland ranks second to Burma as a British tungsten producer. Gives output for 1913 and 1917 by districts and reviews the occurrences. Says veins mined in Wolfram district average 2.3 per cent of WO_3. Reviews briefly the deposits in New South Wales, Victoria, South Australia, Northern Territory, Western Australia, and Tasmania. Gives a table showing the destination of the exports in 1913 when two-thirds went to Germany. All went to England during the Great War. Reviews New Zealand occurrences and gives a table of production for 1916 and 1917. Says 334 tons of ore were shipped from the Straits Settlements in 1915, of which 80 per cent was wolframite and the rest scheelite. The chief producer was the Tati mine. Mentions "Unfederated Malay States;" gives value of production of Union of South Africa; gives a paragraph on Rhodesia (11¾ tons, valued at £2,070, in 1917), and reviews Canadian deposits.

Jones, W. R., general manager, High Speed Steel Alloys Mining Co. (Ltd.). Tavoy, Burma, Tungsten in Manganese ore: Eng. and Min. Jour., Nov. 2, 1918, pp. 779–780.

In moist countries, such as lower Burma, Siam, and the Malay states, it is common to find wolframite so weathered that only deposits of the oxides and hydroxides of manganese and of iron, or of tungstic acid, remain. In some deposits what is left after the weathering of the wolframite is almost a pure manganese mineral; in others it is limonite, and in still others no manganese or iron mineral is left, but only the greenish-yellow mineral tungstite, almost as pure as that obtained in the laboratory. Other products of the weathering of wolframite are also known.

Whether the wolframite is replaced by manganese minerals, by iron minerals, or by tungstite appears to depend on the following:

(*a*) The original composition of the wolframite. The wolframite as found in the countries named is almost invariably composed of the huebnerite and ferberite molecules mixed in varying proportions.

(*b*) The composition of the water acting on the wolframite. The water generally has an acid reaction due to decaying vegetation and the decomposition of unstable sulphides and arsenides. Occasionally it has an alkaline reaction from the alteration of feldspar. The presence of manganese or iron in solution in the water before it attacks the wolframite appears also to be of importance in determining how the wolframite will weather.

Careful prospecting has shown that, although tin ore may be present in the alluvial deposits and is obviously derived from the lodes carrying wolframite and tin ore, the wolframite has been removed chemically owing to its good cleavage exposing new surfaces and to its instability.

Gives an analysis by H. R. Pepper of impure manganese dioxide from a wolframite vein in phyllite as follows: MnO, 90.38; WO_3, 4.2; Al_2O_3, 4; and SiO_2, 1.80 per cent. The material gave place on each side to wolframite carrying more than 70 per cent of WO_3.

See also Palmer and Sharwood.

Jones, W. R. The origin of wolfram deposits: Min. Mag. (London), vol. 18, pp. 319–320, June, 1918.

Abstract of a lecture at Tavoy, under the auspices of the Government Mining Advisory Board. Makes the point that minerals formed by dry fusion belong to the basic rocks and those requiring fluxes or solvents belong to the acidic type, with which tungsten minerals occur. Says that tin, tungsten, molybdenum, and bismuth minerals, pyrite, and arsenopyrite were formed through magmatic gases and solutions. Thinks borates, fluorides, chlorides, tungstates, vanadates, and others may have acted as catalysers. Says that tungsten veins are richest along the walls, and thin veins are the richest because the walls were cold and chilled the solutions and precipitated the minerals. Large masses of tungsten minerals in the middle of thick veins do not disprove the statement, for some lodes have had later intrusions. Says tin and tungsten minerals occur as primary minerals in otherwise ordinary granite in Tavoy—a statement on which considerable light seems desirable. "Pegmatite and quartz veins" extend "several hundred yards into the adjacent schists and phyllites," owing to the presence in the solutions of "fluxes" when injected. Considers sulphides take the place as "carriers" occupied in Malaya by fluorides (tourmaline, topaz, and fluorite). At Mergui, between Tavoy and Malaya, both tourmaline and sulphides are fairly common. Believes that in a general way Tavoy has more tungsten in proportion to tin than Malaya, because denudation of the granite has been less. Admits that unmixed veins of both minerals are found in Tavoy and Mergui. Says the proportion of tin in some mines is becoming greater. Mentions a mine at Sadisdorf (Germany) in which cassiterite gives way to wolframite in depth. Thinks temperature below may have been lower than above. Showed a wolframite crystal with cassiterite crystals perched on it "showing the exceptional in nature."

Kruh, O. The tungsten arc: Electrotech. u. Machinebau, vol. 36, pp. 345–348, 1918. Science Abstracts 21B, p. 450. Abstract by W. E. Ruder in Chem. Abstracts, vol. 13, pp. 1284–1285, 1919.

"Various methods have been adopted for forming an arc between tungsten electrodes, such as an electromagnetically controlled contact, a conical element interposed to strike the arc, or, lately, ionization methods involving the heating of a rod composed of suitable alkaline earth oxides. In the case of the 'Pointolite' (England) lamp, the distribution of pressure in the arc is discussed, and it is remarked that the fall of pressure at the electrodes depends on the nature of the gaseous atmosphere, being least for argon and greatest for hydrogen. Light from the tungsten arc is rich in actinic rays, and the nature of the source lends itself to projections and ultramicroscopic work. The consumption is said to be 0.4 watt per candlepower and the intrinsic brilliancy about 40 candlepower (Hefner) per sq. mm."

Leon, J. M. Y. Yacimientos metalíferos—Minerales de tungsteno: Cuerpo Ing. minas Perú Bol. 90, 43–47, Lima, 1918.

Lincio, Gabriel. The deposit of stibnite and pyrite in the Nautiloides formations of Su Suergiu, Villasalto, Sardinia: Compt. Rend., vol. 166, pp. 737–738, 1918. Abstract by L. W. Riggs in Chem. Abstracts, vol. 12, p. 1956, Oct. 10, 1918.

Antimony is mined at Su Suergiu in an ore vein situated between the black Silurian shale and the upper Devonian limestone. In these dislocated beds stibnite forms veins by replacement of calcite. Lenticular masses of scheelite are found inclosed in the stibnite, and the latter is rarely found crystallized in vugs. It is generally associated with calcite, sometimes with barite, and with smaller amounts of quartz, pyrite, and cinnabar. In the black Silurian shale are spheroids of pyrite arranged around a fossil nucleus, apparently a nautiloid. The suggested explanation of this pyritization of organisms, as well as the pyritization of the black mud of the North Sea, is in the presence of H_2S and the salts of iron. The interior of unaltered spheroids contains no trace of stibnite, but the mineral exists on their surfaces, showing that the antimony impregnation was later than Silurian time.

Lloyd, G. C., and others. Report on the sources and production of iron and other metalliferous ores used in the iron and steel industry, 2d ed., pp. 163–172, London, Dept. Sci. and Ind. Research, Advisory Council, 1918.

A very general article describing uses, world production, and distribution of tungsten, the manufacture of ferrotungsten and metallic tungsten.

The Mining Journal (London) of June 22, 1918, pages 3 and 4, makes the following remarks on a part of the report:

"The proposal is that a prohibitive export duty of £25 per ton shall be levied on all wolfram ore leaving the Empire; secondly, that no transfer or mortgage of any deposit of wolfram ore shall be allowed without Government approval and certificate; and thirdly, that all leases or sales of properties shall contain a restrictive clause in this sense. The reason advanced for this measure is the fear of some of the present British manufacturers of tungsten that 'they will not be able to continue in the trade after the war in competition with German manufacturers, and that it is necessary to prevent the trade from being crushed by organized attacks by their competitors abroad either by underselling or single cornering ore supplies.' Under these circumstances, why confine protection to wolfram only? Clearly, if the contention is right, the restriction ought to apply to all tungsten ores equally. We have, since the outbreak of the war, dominated the situation, the reason being, of course, that the bulk of the production was at that time from British territory. We have now, according to the report, some eight or nine works reducing tungsten ores, and would, of course, have had more but for the reluctance of the Government to permit fresh enterprises to start. Only if the smelters refuse to treat at all may the miner under various conditions of limitation offer the ore to foreign buyers when he may sell it for 'the world's price.'

"The recommendation in the report is the more illogical in our view, because the committee recommends that the smelters should receive subsidies or special consideration as regards excess profits tax for the money sunk in the industry, not merely for their smelters, but for the mines or concessions which they have acquired.

"Thus, the production of high-speed and other tungsten steels in this country is given as 20,000 tons per annum, 8,000 consumed in England, the balance exported, for which the equivalent of 3,000 tons of tungsten metal are necessary. The normal peace requirement is given as 8,000 tons, calling for 1,200 tons of metallic tungsten. It is stated that 2¼ tons of concentrates—presumably 65 per cent—are required to produce the equivalent of 1 ton of metal.

"We have ventured to point out on previous occasions that an entente and a fortiori an alliance with the United States was going to make restrictive action in regard to mineral resources a very delicate question, and unfortunately this report is put forward without any relation to larger considerations of this kind."

Maufe, H. B., Tungsten ores in southern Rhodesia: Southern Rhodesia Geol. Survey Short Rept. No. 4, 6 pp., 1918.

A general article describing conditions of sale, tungsten minerals, known localities of occurrence, geology, and concentration methods.

Conditions of marketing are described thus:

"Early in the war the Imperial Government fixed a maximum price for tungsten ores and their products and prohibited their export from British dominions. * * * The British South Africa Co. a short time ago received information that the Ministry of Munitions has agreed to increase the price of tungsten ore to 60 shillings a unit on a 65 per cent basis of tungstic acid. This means that an ore containing 65 per cent of tungstic acid is valued at 60 shillings times 65, equals £195 per long ton.

"£195 is the price paid for a long ton of dry ore delivered in warehouse, London. From this is to be deducted rail, freight, and insurance to London, half cost of sampling and assay (about £2 10/0), brokerage (1 per cent), and interest on freight, etc. Messrs. H. A. Watson Co. are the official brokers.

"If the ore does not assay as much as 65 per cent, a penalty of 3d. per unit is made for ore down to 60 per cent. For each unit below 60 per cent down to 55 per cent, the penalty is 6d. per unit. Thus, a ton of ore assaying 61 per cent is valued at 59 shillings times 61, equals £179 19/0.

"The ore must be reasonably free from impurities, such as tin, bismuth, arsenic, and excessive sulphur. If the ore contains more than 1 per cent of tin, there is no penalty up to 4 per cent, but the tin will not be paid for. If there is over 4 per cent, the producer will receive the value of the tin, but will have to pay the costs of the separation.

"With regard to shipping charges, the Imperial Government agrees to pay the difference in freight and insurance between the amount actually paid and the rates ruling in September, 1915. This means that the producer's expenses for shipping the ore to England are definitely limited on items liable to fluctuation. It appears that freight in September, 1915, was 30 shillings, as against 165 shillings, with a 20 per cent war surcharge at the present time, whilst war-risk insurance was £1 per cent as against £5 5/0 now. It is unlikely that the producer's shipping expenses can amount to more than £35 per ton of ordinary ore. A good profit seems to be assured."

Metallurgical and Chemical Engineering. The Parker rust-proofing process: Vol. 18, pp. 264–265, 1918.

Iron or steel is cleaned by sand blasting or pickling or immersion in Na_2CO_3. It is then dipped in a solution consisting of acid metaphosphate of tungsten, molybdenum, etc. Finally the metal is treated with a special oil whereby a soft, black, dull finish is obtained.

Miller, Joseph. The Storey's Creek tin-wolfram mine: Min. Mag. (London), May, 1918, p. 264.

Quotes from the Chemical Engineering and Mining Review for December an article giving the results obtained by the Thompson-Davies magnetic separator, made by the Rapid Magnetting Machine Co., of Birmingham.

Mining Magazine (London), South Crofty: Vol. 18, pp. 166–167, April, 1918.

"The ore sent to the mill was 70,055 tons, and the yields of tin concentrate, wolfram concentrate, and white arsenic were 610 tons, 87 tons, and 828 tons, respectively. A small amount of copper concentrate was also saved. The yields per ton of the three products were 19.5 pounds, 2.8 pounds, and 26.5 pounds, and the receipts per ton accruing from them were 24s. 1d., 4s. 2d., and 11s. 6d., respectively. The cost per ton at the mine was 25s. 7d. After deducting all expenses and allowing for depreciation the net profit was £41,530, out of which £35,000 was distributed as dividend."

Mining Magazine (London), Correspondence, Camborne, British tungsten mines: Vol. 18, p. 199, April, 1918.

"Work on the wolfram property situated at Buttern Hill, in the Altarnum district, has been suspended, after a large sum of money, stated to be £30 000, has been expended on plant and buildings. The cause of the suspension is that what was thought to be wolfram proved to be ilmenite. However, there are engineers of standing who still hold the opinion that this is a most promising wolfram prospect, and that the mistake was made in attacking the wrong part of the property, where it was known that ilmenite existed."

Palmer, W. S. The occurrence of tungsten in manganese ore: Eng. and Min. Jour., vol. 105, p. 780, 1918.

The presence of tungsten in a number of manganese oxides from Nevada, particularly from Sodaville, is noted. The WO_3 content varies from 1.0 to 3.05. Other minerals present are calcite, psilomelane, and pyrolusite. The form in which the tungsten exists is as yet undetermined, but it can not be separated by mechanical concentration.

See also Jones and Sharwood.

Penang Gazette, Mining in southern Siam: Reprinted in Commerce Repts., June 18,1918, pp. 1062–1063.

Gives a description of Chinese methods of mining in Siam and refers briefly to the tungsten mines.

Runner, J. J., and Hartmann, M. L. The occurrence, chemistry, metallurgy and uses of tungsten, with special reference to the Black Hills of South Dakota: South Dakota School of Mines Bull. 12, 264 pp. 11 plates (incl. 15 photo reps. and 3 maps), 2 figs., Rapid City, September, 1918.

Part 1 is by Runner. Chapter 1 describes tungsten minerals and deposits and the characteristics of the world's principal deposits. Believes that "scheelite frequently occurs as a secondary mineral, while the wolframites apparently rarely do."

Chapter 2 covers the geology of the Black Hills and chapter 3 the tungsten deposits of the region. The ores are confined to three areas—(1) In the western, northwestern, and northern part of the granite area near Harney Peak; (2) near Lead and Deadwood; and (3) the Nigger Hill district, 15 miles west of Lead. Finds five types of deposits—(1) pegmatites, (2) quartz veins, (3) replacements, (4) segregations, and (5) placers. Types 1, 2, and 5 are confined to the Harney Peak and Nigger Hill district, and types 2 and 4 to the Lead-Deadwood district. Lithium-bearing pegmatites have a complex mineralogy and seem to carry little tungsten. The non lithium-bearing simpler pegmatites, especially in the quartz-rich phases, carry more wolframite. Tin veins carry feldspars, quartz, muscovite, and in places wolframite. Other quartz veins, and these are the most important as sources of tungsten, carry mica and graphite [from the graphitic schists—F. L. H.] None of the deposits are large. In the Nigger Hill area only a little wolframite has been found. It occurs in the tin-bearing pegmatites.

In the Lead-Deadwood district are pre-Cambrian folded and metamorphosed sedimentary, intrusive, and basic igneous rocks; Cambrian conglomerates, sandstones, impure dolomites, limestones, and shales; thin Ordovician limestones; Mississippian limestones, both thin bedded and massive; and numerous Teriary intrusive dikes, sills, and laccoliths of rhyolite porphyry. The rhyolite porphyry is closely connected with the tungsten deposits. On the Homestake property the wolframite deposits replace Cambrian dolomite and thin layers of calcareous shale and also occur in the quartzite and as a cement in the conglomerate. The replacement has occurred from "verticals" (narrow vertical veins coming from below) and at one locality had spread an average of 30 feet wide for 500 feet, from an inch to 2 feet in thickness. The tungsten occurs in close connection with gold ore and in places grades into it. Druses of wolframite carry scheelite looking like drops of honey, which he believes to be secondary but gives no proof. Some scheelite is intergrown with the wolframite. Carload lots carry 60 to 61 per cent WO_3, 3 to 4 per cent Mn, 17 per cent Fe, 1 per cent Ca, a minute quantity of P, and traces of Cu, Sn, or Sb.

Describes several other mines with similar deposits. Stone used in the foundation of a house at Deadwood contained perhaps 15 per cent WO_3. It was from a replacement deposit in quartzite on Deadwood Gulch. Considers small deposits found with gold in rhyolite as segregation deposits, but this is very doubtful. Some huebnerite is found in Two-bit Gulch.

In chapter 4 concentration and production are discussed.

Part 2, by Hartmann, begins with chapter 5, and in it and succeeding chapters chemistry, metallurgy, and uses are discussed, and an extensive bibliography is appended.

Sharp, R. C. Wolfram deposits in the Argentine: Min. Mag. (London), vol. 18, pp. 230–233, 3 photo. rep., 1 sketch map, and 2 cross sections, 1918.

The tungsten ores of Argentina are in the Pampa Range lying between 25° and 35° south latitude, and 240 miles east of the Andes, at altitudes ranging from 2,000 to 5,000 feet. The deposits are quartz veins and lenses cutting the pre-Cambrian and Paleozoic rocks. Most veins strike east and dip north. They carry wolframite, wolframine (tungstite), huebnerite and scheelite, bismuthinite (as much as 8 per cent in the concentrates), molybdenite, copper minerals, a little cassiterite, and mica. Pegmatite dikes containing tourmaline strike north and are "of remarkable extent" but carry no wolframite. The principal localities are Cajon, Gualapaji, Amboti, Incasti, Colorados, and Mazan, all in the Province of Catamarca; Guasapampa, Quines, Pisco-Yacu, Concoran, Carolina, San Ramon, and El Morro, in the Provinces of Cordoba, and San Luis. In Mazan, about 35 kilometers north of La Rioja, a small French company has a flat vein 3 feet thick, carrying wolframite and cassiterite. In Concoran a vein 1 meter thick and more than 2 kilometers long at a granite and gneiss contact is worked by a German firm ("controlled by the Krupps"); a 150-ton concentrating plant produces 40 tons of concentrates, mostly jigged, carrying 62 to 65 per cent of WO_3 with some copper and bismuth. The larger tailing dumps contain considerable fines. In Pisco Yacu an English company has a property covering about 8 square miles on which are several veins in gneiss and granite; it has also a mill and makes concentrates carrying 69½ per cent of WO_3, with some bismuth, copper, and molybdenum. An American company operates a mine on the western side of the Morro Mountains and has a stock work of veins in a biotite gneiss; it has a small mill. There are bunches of rich ore at the intersections. There is wolframite float in the beds of the dry creeks; some pieces weigh several pounds. On the San Ramon claim quartz veins follow the planes in gneiss and carry both wolframite and scheelite. Scheelite is partly crystalized; one 2-inch crystal was sent to the South Kensington Museum, London. Women concentrate the ore in pans, but lose much of the scheelite. In general, Argentine veins contain 0.5 to 1.5 per cent of wolframite unevenly distributed in pieces weighing as much as 50 kilograms, so that much barren quartz must be worked over.

Wages 4s. 6d. to 6s; mining claims 300 meters by 250 meters and good titles may be obtained; climate dry and healthful, but during parts of the year there are bad dust storms.

[The Hansa Co., the largest producer, is in Concoran. The Argentine Metals (Ltd.), 46 Reconquista, Buenos Aires, a British company, is in Pisco-Yacu.]

Sharwood, W. J. Tungsten occurring in manganese oxide: Eng. and Min. Jour., vol. 105, p. 1176, June 29, 1918.

Describes psilomelane from oxidized ores at a considerable depth in the Homestake mine at Lead, S. Dak., that carried 1 per cent of WO_3. The gold ores of the Homestake mine are not known to carry tungsten.

See also Jones and Palmer.

Smith, F. W. Efficiency of carbon and gem (graphite) lamps: Elec. Engineering, vol. 52, No. 6, p. 25, 1918. Abstract in Chem. Abstracts, vol. 12, p. 1616, 1918.

Compares 50-watt lamps made with carbon, graphite, and tungsten filaments; the respective candle powers are 16.8, 20.0, 48.1.

Stappenbeck, Ricardo. Wolfram ó tungsteno: Dirección gen. de minas, geología é hidrología, Bol. 19, serie B (Geología), pp. 66–71, Buenos Aires, 1918.

Gives a compilation of known writings on the tungsten production of Argentina. Quotes:

Beder, R., Las vetas de magnetita (martita) y las de wolframita en la falda oeste del Cerro del Morro, provincia de San Luis: Dirección gen. de minas, geología é hidrología, Bol. 2, serie B (Geología), 1913.

Bodenbender, W., La Sierra de Córdoba: Ministerio de Agr., Sec. geología, mineralogía y minería anales, vol. 2, Buenos Aires, 1905.

Bodenbender, W., Los criaderos de wolfram y molêbdenita de la Sierra de Córdoba: Acad. ciencias, Córdoba, Bol., vol. 14, 1894.

Bodenbender, W., Die Wolframminen der Sierra von Córdoba in der Argentinischen Republik; Zeitschr. prakt. Geologie, 1894, pp. 469–414.

Gerth, H., Constitución geológica, hidrogeológica, hydrogeológia y minerales de applicación de la provincia de San Luis: Ministerio de Agr., Sec. mineralogía anales, vol. 10, No. 2, Buenos Aires, 1914.

Kantor, M., Minerales de wolfram en la Sierra de Velasco: Revista del Museo de La Plata, No. 20, 1913.

Keyserling, O. V., Argentinische Wolframerzlagerstätten: Zeitschr. prakt. Geologie, 17 Jahrgang, p. 156, 1909.

Mazza, A. F., Estudio y aplicaciones de los minerales de wolfram y en especial de los de la Sierra de San Luis, Buenos Aires, 1909.

Analyses (Bodenbender): Wolframita de la Cumbre, $4(FeO)WO_3$, $3(MnO)WO_3$ with 74.86 per cent WO_3; wolframita de San Ignacio, $2(FeO)WO_3$, $(MnO)WO_3$ with 75.07 per cent WO_3.

Analyses (Mazza): Tungsten minerals from Los Cóndores:

	Wolframite.	Scheelita.
	Per cent.	*Per cent.*
WO_3	69.975	79.622
FeO	11.296	....
MnO	10.744	....
Fe_2O_3	4.356	.106
SiO_2	1.701	2.234
CaO	1.046	17.953
$Nb_2O_5.V_2O_5$	.625	....
	99.743	99.915

Taylor, M. T. The roasting of tin ore: Min. Mag. (London), April, 1918, p. 214.

"Mr. Taylor proceeded to discuss the amount of decrepitation that takes place in both wolfram and tin ores during calcination. This decrepitation has the effect of comminuting the mineral, and as the material has subsequently to undergo the second series of concentration, the increased fineness leads to losses. * * * The ores treated in his experiments were rich in mineral practically free from gangue."

Two tests were made on wolfram and four on tin ore. The first temperature was 1,500° F. The original materials for these tests were minus 40 plus 60. It was found that of the wolfram material after calcination 61.1 per cent went through 60 mesh, while 18.5 was minus 200. The temperature was then raised to 2,000° F., and the same ore samples were used; the result was that 73 per cent went through 60 mesh, while 21 per cent was minus 200. The latter product was extremely fine, resembling graphite, and on a vanning assay very little could be retained. With the tin ore, the original products were the same as the wolfram, namely, minus 40 plus 60, and the samples were obtained direct from the mine, not being previously crushed or treated. The tin ore at 1,500° F. showed that after calcination 21.25 per cent passed through 60 mesh and 2.25 per cent was minus 200, while at a temperature of 2,000° F. 22 per cent passed through 60 mesh and 3.25 per cent was minus 200. In the wolfram treated at 2,000° F. very little sintering was noticeable to the naked eye, but with the tin product an excessive amount of sintering and of fusing was in evidence. The above figures prove that calcination should not be carried out at a temperature above 1,500° F., and that the higher the temperature the greater the decrepitation. From the evidence so far obtained it would appear that a temperature between 1,100° and 1,300° F. is a suitable one for calcination.

Young, G. A. Burnthill Brook map area, New Brunswick: Canada Geol. Survey Summ. Rept., 1917, part F, pp. 1F–14F, 1 geol. map and 1 sketch map, 1918.

The deposit is only about 50 miles east of the Maine boundary. Quartz veins carrying wolframite cut early Paleozoic metamorphosed sediments cut by Devonian granite. Quotes descriptions of Walker, Camsell, and Cairnes.

RECENT PATENTS.

Fahrenwald, F. A. Soldering or brazing tungsten or molybdenum with nonoxidizing metals: U. S. patent No. 1,261,110, April 2, 1918. Abstract in Chem. Abstracts, vol. 12, 1918.

Tungsten may be coated with gold, preparatory to soldering or brazing it, by immersing the tungsten in a bath of sodium carbonate or borax and then treating it at a temperature not exceeding about 1,350°C. with molten gold for not longer than 30 seconds. Gold and palladium together may be used for coating tungsten or molybdenum, as may also silver, platinum, or their alloys. After coating with the nonoxidizing metal the ductile tungsten or molybdenum may be soldered or brazed.

Fahrenwald, F. A. Soldering tungsten or molybdenum or their alloys: U. S. patent No. 1,263,656, April 23, 1918. Abstract in Chem. Abstracts, vol. 13, p. 1639, 1918.

The surfaces to be soldered are first coated with a flux composed of finely divided silver, gold, or platinum mixed with sodium carbonate, borax, or other alkali metal compositions and heated to a temperature at least as high as the melting point of the metal in the flux. A soldering metal or alloy is then applied which will alloy with the metal of the flux; for example, gold alloyed with palladium, iridium, copper, or silver. Silver, gold, palladium, or platinum chlorides may replace the metals in the flux.

Farkas, K. Drawing tungsten wire: U. S. patent No. 1,253,362, January 15, 1918. Abstract in Chem. Abstracts, vol. 12, p. 657, 1918.

In drawing tungsten wire through a heated diamond die the surface of the wire is lubricated by an aqueous paste of magnesium and the lubricated wire is heated before passing it through the die.

FULLER, C. T. Tungsten filaments: U. S. patent No. 1,280,704, October 8, 1918. Chem. Abstracts, vol. 13, p. 10, January 10, 1919.

Tungsten filaments which have been formed by ordinary mechanical drawings are heated at least to redness in an oxidizing atmosphere, after which they may be heated to a higher temperature in vacuo or in an inert gas to increase their ductility and pliability and improve their capacity for retaining these properties during use in incandescent lamps. The process is especially adapted for the treatment of "nonoffsetting" filaments.

HAMILTON, E. M. Obtaining tungsten from ores: U. S. patent No. 1,261,383, April 2, 1918. Abstract in Chem. Abstracts, vol. 12, p. 1541, 1918.

Tungstic acid is obtained from tungsten ore by adding water to the ground ore or concentrates to form a pulp, treating the pulp with sodium carbonate to form a soluble compound (the quantity of solution present being one to two times the quantity of ore), and heating the pulp and solution under pressure to effect complete reacting. The solution is filtered off and tungstic acid is precipitated from it by the addition of hydrochloric acid.

JAEGER, H. J. Electric lamp metallic filament and process of making it: U. S. patent No. 1,265,204, May 7, 1918.

A "concentrated" metallic filament is coated with a chloride of a metal of the chromium group, such as uranium, and the lamp is filled with an inert gas, exhausted, and sealed. The filament is then heated so that the chloride is decomposed and uranium deposited on the filament.

LEDERER, ANTON. Tungsten wire: U. S. patent No. 1,273,506, July 23, 1918. Abstract from Chem. Abstracts, vol. 12, p. 1862, 1918.

In drawing tungsten wire the tungsten is covered with sulphur, which acts both as a protection against oxidation and as a lubricant. After drawing the wire the sulphur remaining on it is removed by heating. Selenium or tellurium may be similarly used instead of sulphur.

PFANSTIEHL, C. A. Electric furnace for sintering or welding ingots: U. S. patent No. 1,260,940, March 26, 1918. Chem. Abstracts, vol. 12, p. 1442, 1918.

The furnace has a pair of carbonized tungsten electrodes between which ingots to be welded are placed.

PFANSTIEHL, C. A. Tungsten-reducing furnace: U. S. patent No. 1,263,598, April 23, 1918. Abstract in Chem. Abstracts, vol. 12, p. 1619, 1918.

Tungsten trioxide is introduced into the furnace on nickel trays, arranged one above the other, so as to provide a passage for hydrogen between the trays. The hydrogen is brought into direct contact with an electric heating element.

SCHALLER, O. Unitary-tungsten crystals in filament form: U. S. patents Nos. 1,256,929 and 1,256,930, February 19, 1918. Abstract from Chem. Abstracts, vol. 12, p. 884, 1918.

Same as Ely, O.; see page 1016.

WRIGHT, D. K. Shaping tungsten filaments: U. S. patent No. 1,265,575, May 7, 1918. Abstract in Chem. Abstracts, vol. 12, p. 1617, 1918.

Tungsten filaments are shaped by winding the tungsten wire about two conducting supports so as to form straight portions of the wire between the supports, and then passing an electric current through the supports so that the straight portions of the wire will carry a much greater current than the bends and are heated to a temperature of about 2,000°, whereas the bends are but slightly heated and retain most of their resiliency.

ZINC.

(GENERAL REPORT.)

By C. E. Siebenthal

SUMMARY.

Zinc produced and consumed in the United States, 1917–18, in short tons.

	1917	1918
Production of primary zinc:[a]		
From domestic ore	584,597	492,405
From foreign ore	84,976	25,522
	669,573	517,927
Production of secondary zinc:[a]		
Redistilled	16,835	9,918
Remelted	14,565	17,190
	700,973	545,035
Apparent consumption of primary zinc	413,643	423,792

[a] "Primary zinc," which is produced directly from ore, is here distinguished from "secondary zinc," which is obtained by refining zinc ashes, skimmings, drosses, and old metals. The statistics of secondary zinc are given on page 1034. Wherever in this report the word "zinc" is used without qualification it means primary zinc.

The production of primary zinc from domestic ores in 1918 was 492,405 short tons, valued at $89,618,000, based on the average selling price, as compared with 584,597 short tons, valued at $119,258,000, based on the average selling price, in 1917—a decrease of 92,192 tons, or nearly 16 per cent, in quantity and of $29,640,000, or about 25 per cent, in value.

INTRODUCTION.

An estimate of the production of zinc in the United States in 1918 was published on January 2, 1919. That estimate was based on reports from every zinc smelter in operation in 1918, which included actual production for the first 11 months of the year and an estimate of the production in December. The final figures of the production of zinc in 1918 were published June 9, 1919, and in somewhat greater detail in the "Preliminary report on the mineral resources of the United States in 1918," published August 7, 1919. The present report contains, in addition to the statistics given in that statement, tables and curves showing production, value, consumption, imports, exports, and prices for a period of years. Some historical data showing how the zinc industry was affected by the war are also included. A change in the statistics for 1916 is necessitated by the discovery that 887 tons of zinc reported as recovered from secondary material was in reality derived from drosses made in reducing ore in the plant itself and hence, never having been reckoned as metallic zinc, was primary zinc.

The statistics of production of zinc in this country in 1918 have been compiled by the United States Geological Survey from confidential reports submitted by each zinc-smelting company in operation during the year. The statistics of the recovery of secondary zinc were also collected by the Geological Survey. The statistics of domestic consumption are taken in part from the smelter returns and in part from the records of the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, and the statistics of foreign production are compiled from the sources indicated in connection with the tables here presented.

PRODUCTION.

TOTAL PRODUCTION.

The smelting of zinc in the United States began in an experimental way in 1858,[1] and regular production began in 1860 at the Lehigh Zinc Works in the East and at the Matthiessen & Hegeler Works in the West. Between 1864 and 1870, 9 or 10 other zinc smelters were established. Annual statistics have been collected by the United States Geological Survey since 1882. The progress of the zinc-smelting industry since that time is shown in the following table:

Zinc produced in the United States from domestic and foreign ores, 1882–1918, in short tons.

Year.	From foreign ore.	From domestic ore.	Total.	Year.	From foreign ore.	From domestic ore.	Total.
1882		33,765	33,765	1901		140,822	140,822
1883		36,872	36,872	1902		156,927	156,927
1884		38,544	38,544	1903		159,219	159,219
1885		40,688	40,688	1904		[a]186,702	186,702
1886		42,641	42,641	1905		[a]203,849	203,849
1887		50,340	50,340	1906	25,076	199,694	224,770
1888		55,903	55,903	1907	26,115	223,745	249,860
1889		58,860	58,860	1908	19,675	190,749	210,424
1890		63,683	63,683	1909	25,535	230,225	255,760
1891		80,873	80,873	1910	16,705	252,479	269,184
1892		87,260	87,260	1911	14,905	271,621	286,526
1893		78,832	78,832	1912	14,899	323,907	338,806
1804		75,328	75,328	1913	9,424	337,252	346,676
1895		89,686	89,686	1914	9,631	343,418	353,049
1896		81,499	81,499	1915	31,384	458,135	489,519
1897		99,980	99,980	1916	104,005	[b]564,338	[b]668,343
1898		115,399	115,399	1917	84,976	584,597	669,573
1899		129,051	129,051	1918	25,522	492,405	517,927
1900		123,886	123,886				

[a] Including an unknown quantity smelted from foreign ore, small in 1904, but larger in 1905.
[b] Revised figures (see p. 1027.)

The following table shows the source of the primary zinc smelted in the United States since 1906. The extent to which the United States has utilized the zinc ores of her neighbors to the north and the south and her dependence upon the zinc ores of other countries because of the great demands during the World War are readily seen.

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[1] Ingalls, W. R., Lead and zinc in the United States, p. 314, 1908.

Zinc smelted in United States, 1906–1918, apportioned according to sources of ore, in short tons.

Year.	United States.	Canada.	Mexico.	Europe.	Asia.	Australia.	Africa.	Other countries.	Total.
1906	199,694	201	24,875	....	....	....	....	....	224,770
1907	223,745	545	25,570	....	....	....	....	....	249,860
1908	190,749	2,425	17,250	....	....	....	....	....	210,424
1909	230,225	978	24,557	....	....	....	....	....	255,760
1910	252,479	3,304	13,401	....	....	....	....	....	269,184
1911	271,621	1,598	13,307	....	....	....	....	....	286,526
1912	323,907	4,199	10,700	....	....	....	....	....	338,806
1913	337,252	1,424	6,205	1,175	620	....	....	....	346,676
1914	343,418	4,538	5,093	....	....	....	....	....	353,049
1915	458,135	5,103	13,943	1,073	1,030	10,235	....	....	489,519
1916	564,338	24,376	20,694	12,717	1,905	41,958	2,355	....	668,343
1917	584,597	6,787	40,360	11,689	....	26,140	....	....	669,573
1918	492,405	8,700	14,043	113	....	1,780	....	[a] 886	517,927

[a] All South America.

The following table shows the States in which the zinc smelting of the United States has been done since 1906. It shows the beginning of recent zinc smelting in Arkansas and the beginning and great expansion of zinc smelting in Oklahoma. The expansion of zinc smelting in Illinois is also registered, as well as vicissitudes in the zinc-smelting industry of Kansas. The excess of demand for zinc in 1915–16 over active smelting capacity led to the revival of numerous abandoned smelters in Kansas and resulted in 1916 in the largest output of zinc in the State's history. Since that time the increasing cost of natural gas and of labor in the hand-worked plants, together with the low price of zinc, has practically eliminated what had been an important industry in that State since 1874.

Zinc produced in the United States, 1906–1918, apportioned according to States in which smelted, in short tons.

Year.	Illinois.	Kansas.	Oklahoma.	Pennsylvania.	Arkansas	Other States.	Total.
1906	47,939	129,564	....	8,659	....	38,608	224,770
1907	56,056	134,108	5,035	11,266	....	43,395	249,860
1908	50,244	99,298	14,864	6,818	....	39,200	210,424
1909	67,653	103,299	28,782	15,222	....	40,804	255,760
1910	73,038	105,697	34,760	16,459	....	39,230	269,184
1911	83,130	98,413	46,315	15,337	....	43,331	286,526
1912	88,397	101,104	76,925	18,254	....	54,126	338,806
1913	106,654	74,106	83,214	26,934	....	55,768	346,676
1914	127,946	44,510	91,367	28,095	....	61,131	353,049
1915	159,958	101,423	109,208	44,167	....	74,763	489,519
1916	181,433	141,286	168,206	76,545	7,503	93,370	668,343
1917	172,489	76,048	204,394	86,995	25,660	103,987	669,573
1918	141,844	29,149	139,066	77,342	26,753	103,773	517,927

The collection of statistics of zinc production at short intervals during the period of participation of the United States in the war gives the data for the following table. As shown by the totals, these figures include redistilled secondary zinc.

Zinc produced in the United States, 1917–18, by months, in short tons.

Month.	1917	1918
January	62,785	39,896
February	55,593	43,624
March	65,929	53,818
April	63,031	42,504
May	64,680	40,036
June	59,399	47,516
July	57,677	40,033
August	54,960	49,610
September	50,599	40,433
October	53,493	39,687
November	50,113	48,609
December	48,149	42,079
	686,408	527,845

DISTILLED AND ELECTROLYTIC ZINC.

Selected secondary zinc materials, such as zinc ashes and scrap, carefully redistilled, yield zinc of all grades, which enter the market for practically all purposes. Considerable secondary material, as explained on page 1034, is mixed with ore and used by some regular ore smelters. Though the quantity of metal so derived can be calculated by the smelters and thus eliminated from the output of primary zinc, it is practically impossible to segregate the redistilled secondary zinc by grades or in smelter stocks. Hence the smelter stocks as given contain some secondary zinc, and the statistics of production of zinc by grades as given in the table below likewise include secondary zinc. The quantity of secondary zinc included in the graded zinc is given in the second part of the table, which gives the source of the graded zinc by the methods of reduction. The growing output of electrolytic zinc is shown.

During the war, when so much zinc was bought on Government specification, it became the custom to give the grade of zinc by letters, as "grade A," instead of "high grade," "grade B," instead of "intermediate," and so on. A table is given on page 1060 which shows the limits of impurities permissible in the different grades as defined by certain testing societies and Government departments.

Distilled and electrolytic zinc produced in the United States, 1914–1918, in short tons.

Apportioned according to method of reduction.

	1914	1915	1916	1917	1918
Electrolytic	....	252	[a] 11,116	[a] 25,209	[a] 38,916
Distilled primary	353,049	489,267	657,227	644,364	479,011
Redistilled secondary zinc	20,545	29,764	28,776	16,835	9,918
	373,594	519,283	697,119	686,408	527,845

Apportioned according to grade.

	1914	1915	1916	1917	1918
Grade A (high grade)	19,385	54,056	73,405	97,707	129,344
Grade B (intermediate)	32,076	69,751	94,825	69,189	68,967
Grade C (select and brass special)	68,551	93,131	100,875	148,749	98,584
Grade D (prime western)	253,582	302,345	428,014	370,763	230,950
	373,594	519,283	697,119	686,408	527,845

[a] Prime western zinc refined by electrolysis in addition: In 1916, 1,800 tons; in 1917, 1,701 tons; in 1918, 753 tons.

ROLLED ZINC.

For many years nearly all the sheet zinc made in the United States was produced by two of the older and larger companies—the Matthiessen & Hegeler Zinc Co., of La Salle, Ill., and the Illinois Zinc Co., in the adjoining town of Peru, Ill. Other companies, particularly the manufacturers of glass fruit jars having zinc tops, have rolled zinc for their own use, and some that furnish sheet zinc to lithographers have also rolled their own zinc. The great demand during the war for sheet zinc to line packing cases made for shipment overseas, especially cases containing munitions or other material that was likely to be affected by salt air, led still other firms into the business of rolling zinc. In addition to the two companies specifically mentioned above, the following firms now make rolled zinc: Ball Bros. Glass Manufacturing Co., Muncie, Ind.; Hazel-Atlas Glass Co., Wheeling, W. Va.; New Jersey Zinc Co., Palmerton, Pa.; American Zinc Products Co., Greencastle, Ind.; Edes Manufacturing Co., Plymouth, Mass.; E. Phillips & Sons, South Hanover, Mass.; The Platt Bros. & Co., Waterbury, Conn.; and Scovill Manufacturing Co., Waterbury, Conn.

A canvass of the industry by the United States Geological Survey gives the statistics presented in the following table. If the figures showing exports, as published by the Bureau of Foreign and Domestic Commerce, are subtracted from the figures showing production, the result will represent the apparent domestic consumption. It should be borne in mind, however, that the sheet zinc used by the Government in shipping munitions overseas is not reported as exported.

Zinc rolled in the United States, 1915–1918.

	1915	1916	1917	1918
Zinc sheets:				
Quantity .... pounds..	69, 007, 725	65, 836, 170	75, 730, 006	79, 745, 237
Value	$9, 744, 026	$12, 280, 644	$13, 854, 600	$12, 611, 294
Average price per pound	$0. 141	$0. 187	$0. 183	$0. 158
Boiler plates and special sheets:				
Quantity .... pounds..	2, 562, 856	3, 198, 693	6, 900, 293	14, 223, 673
Value	$345, 572	$564, 814	$1, 111, 240	$1, 912, 578
Average price per pound	$0. 135	$0. 177	$0. 161	$0. 134
Zinc strips:				
Quantity .... pounds..	[a] 20, 222, 628	[a] 28, 159, 495	[a] 36, 253, 122	45, 804, 915
Value	[a] $2, 939, 330	[a] $5, 029, 731	[a] $5, 810, 450	$6, 381, 582
Average price per pound	$0. 145	$0. 179	$0. 160	$0. 139
Total rolled zinc:				
Quantity .... pounds..	91, 793, 209	97, 194, 358	118, 883, 421	139, 773, 825
Value	$13, 028, 928	$17, 875, 189	$20, 776, 290	$20, 905, 454
Average price per pound	$0. 142	$0. 184	$0. 175	$0. 150
Rolled zinc exported:				
Quantity .... pounds..	....	25, 024, 182	33, 027, 991	27, 750, 910
Value	....	$4, 540, 146	$5, 730, 792	$4, 566, 756
Average price per pound	....	$0. 181	$0. 174	$0. 165
Apparent consumption of rolled zinc... pounds..	....	72, 170, 176	85, 855, 430	112, 022, 915

[a] Revised figures.

The New Jersey Zinc Co. made its first output of rolled zinc in 1917, and the American Zinc Products Co. in 1918. Additions to capacity amounting to nearly 50 per cent were made at four of the principal mills to meet the increased demand for sheet zinc for war uses and the demand that will result from the prevailing strong movement to find and establish new uses for sheet zinc and to extend the present uses.

Rolled zinc has always been quoted at so much a pound with discounts and extras for different gages and special sizes and shapes. In 1914, according to Metal Statistics, the base price ranged from 7 to 8.75 cents a pound. In 1915 the price began at 8.75 cents, rose to 33 cents on June 9, fell to 15 cents on August 23, and rose to 23 cents at the end of the year. In 1916 the price reached 25.5 cents on April 22 but dropped to 15 cents on July 11 and ended the year at 21 cents. In 1917 the base price of sheet zinc remained nearly stationary, declining to 20 cents on April 25 and to 19 cents on April 26. On February 15, 1918, the base price of zinc sheets was fixed by the Government at 15 cents and the price of rolled zinc plates at 14 cents, and these prices prevailed during the remainder of the year. The price of high-grade Joplin concentrates purchased by smelters intending to roll the zinc was fixed by agreement at $75 a ton for concentrates containing 60 per cent of zinc.

Both the production and the value by classes of product given in the table are subject to slight correction, because some producers who sell from a single base price do not keep their sales separated according to classes of product (which are arbitrary, anyhow) and were to that extent obliged to make estimates; others, who themselves use the greater part of their output, had to estimate values. But the total production, value, and average selling price given may be considered accurate. The average selling price agrees closely with the average value shown by the exporter's manifests.

ZINC DUST.

Zinc dust has been marketed by domestic smelters since 1910. The United States Zinc Co., at Pueblo, Colo., was the first to prepare it for the market; the Grasselli Chemical Co. followed later; and one by one other companies began to save zinc dust, until in 1918 the companies named below reported production, a part of which consisted of "atomized" zinc dust made by subjecting a small stream of molten zinc to a blast of air.

American Zinc & Chemical Co., Langeloth, Pa.
Anaconda Copper Mining Co., Great Falls, Mont.
Bartlesville Zinc Co., Bartlesville, Okla.
John Finn Metal Works, San Francisco, Calif.
Grasselli Chemical Co., Clarksburg and Meadowbrook, W. Va.
Illinois Zinc Co., Peru, Ill.
The Merrill Co., San Francisco, Calif.
Metals Disintegrating Co., New York, N. Y.
National Zinc Co., Bartlesville, Okla., and Springfield, Ill.
New Jersey Zinc Co., Palmerton, Pa.
United States Zinc Co., Pueblo, Colo.

The following table gives the output of zinc dust since its first production in a commercial way in the United States:

Zinc dust produced in the United States and imported, 1910–1918.

Year.	Production.						Imports.		
	Prepared "blue powder."			Zinc dust "atomized."					
	Quantity (short tons).	Value.[a]	Average selling price per pound.	Quantity (short tons).	Value.[a]	Average selling price per pound.	Quantity (short tons).	Value.	Average selling price per pound.
1910	69	$9,246	$0.067				1,493	$136,749	$0.046
1911	254	36,576	.072				1,713	177,420	.052
1912	492	73,800	.075				2,736	306,061	.056
1913	423	62,604	.074				2,368	248,482	.052
1914	1,004	184,736	.092				2,004	191,582	.048
1915	1,755	940,680	.268				707	137,474	.097
1916	2,548	1,097,397	.215	61	$26,230	$0.215	522	230,380	.221
1917	3,989	1,322,196	.166	1,924	642,782	.167	233	48,604	.104
1918	4,016	877,171	.109	2,979	773,746	.130	16	3,552	.111

[a] Value is calculated from the total value of material sold during year.

ZINC PIGMENTS.

Zinc forms the base, either in whole or in part, of four white pigments—zinc oxide, leaded zinc oxide, zinc-lead oxide, and lithopone. All these may be and in the United States the first three usually have been made directly from zinc ore. No zinc-lead oxide has been made since 1909, when the plant at Canon City, Colo., was closed. The output of zinc oxide and leaded zinc oxide has not been disclosed, as it was confined to one very large producer and several smaller ones.

Lithopone is an intimate mixture by chemical precipitation of zinc sulphide and barium sulphate. It may be manufactured from zinc ore or zinc oxide, but in the United States it is generally made from zinc skimmings, zinc ashes, and scrap zinc. The production of lithopone is growing rapidly, as is shown in the following table:

Lithopone produced and marketed in the United States, 1906–1918, in short tons.

1906 (revised figures)	5,149
1907	10,275
1908	8,292
1909	14,847
1910	12,655
1911	16,866
1912	24,220
1913	29,685
1914	32,819
1915	46,494
1916	51,291
1917	63,713
1918	62,403

The zinc content of the pigments made in the United States from ore, both domestic and foreign, for the period 1908–1918, is given in the table below. On page 1034 statistics of a portion of the secondary zinc recovered in the form of pigments are given.

Primary zinc content of zinc pigments made in the United States, 1908–1918, in short tons.

1908	48,004
1909	54,139
1910	50,592
1911	46,122
1912	64,032
1913	70,622
1914	70,619
1915	79,572
1916	90,276
1917	97,573
1918	102,778

SECONDARY ZINC.

By the ordinary method of galvanizing, in which the material to be coated is dipped into a bath of molten zinc, there is a great loss of zinc in the form of semioxidized skimmings and of hard zinc drosses, consisting of the alloy formed by the zinc with the iron of the tank and the iron of the article that is being galvanized. The larger galvanizing plants have furnaces to resmelt these skimmings and drosses and to recover the zinc. There are also many small plants and some large ones which make a practice of buying galvanizer's skimmings and drosses and of recovering the zinc. A considerable quantity of old metal in the form of various alloys of zinc with copper and other metals is also worked over and brought up to the desired composition by the addition of new metal. At almost every brass foundry and machine shop in the country it is the custom to remelt and use brass filings, grindings, and scrap copper and brass, and it is manifestly impracticable to attempt to take full account of such material. Some of the zinc smelters running on ore find it advantageous to work in a quantity of secondary material, because the loss of zinc in distillation is practically a fixed quantity per charge, whether the charge is of low or high tenor. If secondary material high in zinc is mixed with low-grade ore, the loss per unit of metal recovered is thereby greatly lessened. Where this is done the smelters make proper returns to the United States Geological Survey, and in these reports account has been taken of such production, the output being recorded as dross or secondary zinc. As such zinc has been recovered by redistillation, it is practically indistinguishable in quality from zinc of the usual grades made from ore. Several secondary smelters recover zinc from drosses by redistillation, and these plants are included in the list of smelters on a later page. In the table below the secondary zinc recovered by redistillation is separated from that recovered by remelting. The canvass of secondary smelters was made by J. P. Dunlop, of the United States Geological Survey.

Secondary zinc produced in the United States, 1913–1918, in short tons.

	1913	1914	1915	1916	1917	1918
Secondary zinc, redistilled	25,991	20,545	29,764	[a] 28,776	16,885	9,918
Secondary zinc, remelted	24,014	22,424	23,136	21,037	14,565	17,190
Recovered zinc in alloys, excluding old brass remelted	3,743	3,914	5,300	2,600	4,800	11,082
Recovered zinc in remelted brass	25,822	24,759	34,375	61,700	80,000	82,400
Secondary zinc recovered as metal	79,570	71,642	92,575	114,113	116,200	120,590
Secondary zinc recovered in pigment	3,705	6,536	8,323	8,749	9,204	8,675
Secondary zinc recovered in zinc chloride [b]	6,253	6,429	7,860	6,319	6,248	7,345
Total secondary zinc	89,528	84,607	108,758	129,181	132,000	137,000

[a] Revised figures. (See p. 1027.)

[b] These figures include only the quantity of zinc chloride used in wood preservation and were furnished by courtesy of the Forest Service, Department of Agriculture.

MINE PRODUCTION.

The preceding tables have given the quantity of zinc recovered either as metal by smelting and by electrolytic reduction, or in zinc dust, or as zinc in pigments. The three following tables show the origin of the domestic zinc that is recovered by metallurgic operations. For the origin of the zinc by States the reader must consult the mines reports, because smelters necessarily treat mixtures of ores, sometimes long after they have been received, so that the actual output of metallic zinc may not correspond at all closely to the product of the mines for the same year. The data for the tables of mine production are taken from the mines reports on gold, silver, copper, lead, and zinc in the different States, as indicated in the prefatory note.

The following table gives the zinc output since 1909. Missouri held first rank in mine production of zinc until 1918, but in that year she fell to fourth place and Oklahoma went into first place by virtue of her increasing output, which had practically doubled each year since 1915. New Jersey, which had so long held second place in zinc production, lost it to Montana in 1916 and 1918.

Mine production of zinc in the United States, 1909–1918, in short tons.

State.	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Arizona	2,989	2,742	2,281	4,379	4,714	4,896	9,110	9,839	10,447	1,135
Arkansas	510	994	664	748	478	608	3,209	6,815	6,691	951
California	....	....	1,404	2,173	529	195	6,547	7,628	5,436	2,781
Colorado	25,605	38,545	47,304	66,111	59,673	48,387	52,297	67,143	60,158	44,567
Idaho	676	2,802	4,170	6,953	11,587	21,006	35,077	43,253	39,927	22,581
Illinois	2,163	3,549	4,219	4,065	2,236	4,811	5,534	3,404	4,267	3,792
Iowa	35	96	....	....	....	....	....	21	18	....
Kansas	11,445	13,229	10,272	10,633	10,088	11,284	14,365	12,448	20,249	30,197
Kentucky	56	6	158	491	327	230	764	1,096	751	315
Missouri	130,162	128,589	122,515	136,551	124,963	105,994	136,300	155,960	132,918	55,992
Montana	4,680	15,819	21,905	13,459	44,337	55,790	93,573	114,630	93,130	104,629
Nevada	1,507	1,354	1,774	6,661	7,210	6,490	12,188	16,222	11,154	8,362
New Hampshire	....	....	....	....	15	6	24	36	45	14
New Jersey[a]	83,248	68,584	66,027	76,283	79,070	82,956	117,722	112,020	120,846	98,470
New Mexico	6,543	9,044	5,119	6,783	8,262	9,202	12,702	18,285	15,100	12,025
New York	....	....	81	....	....	....	2,455	4,507	5,192	3,776
North Carolina	....	....	....	142	10	....	....	....	....	....
Oklahoma	7,806	6,394	5,150	5,769	11,664	13,992	14,314	28,754	85,835	161,401
Tennessee	596	966	1,117	2,191	5,583	10,425	16,461	26,428	28,498	21,071
Texas	....	....	....	119	326	108	15	116	11	....
Utah	4,930	8,184	8,920	8,534	9,429	7,995	12,146	14,786	10,643	9,200
Virginia	58	794	1,032	249	2,719	174	1,267	2,276	1,703	951
Washington	....	....	10	....	....	....	122	847	598	19
Wisconsin	23,152	25,927	29,720	33,050	30,110	31,113	41,403	56,803	59,742	50,014
	306,161	327,618	333,842	385,344	413,330	415,662	587,595	703,317	713,359	632,243

[a] The output of New Jersey for 1909–1915 has been revised and likewise the total for the whole country.

The following table shows for each zinc-producing State the total quantity of zinc ore produced and the recoverable zinc content of each kind of zinc-bearing ore. The column headed "All other ore" includes lead ore, copper ore, copper-lead ore, and dry or silliceous ore, no zinc of consequence being recovered from any of them except in California and Colorado. "Dry" ores produced in Colorado in 1918 contained 1,125 short tons of recoverable zinc. Copper-zinc ores produced in California contained 621 tons of recoverable zinc. These ores, however, were concentrated from parts of the ore from certain counties and were not distributed through the whole of the "All other ore" credited to those States in 1918. The total crude ore yielding either gold, silver, copper, lead, or zinc is given for each zinc-producing State, so that a comparison may be made of the relative extent of deep mining operations for all five metals in these States, the quantity of crude ore raised being the best measure for this purpose. The table discloses the fact that Missouri produced a little more than one-ninth of the crude ore output of the zinc-producing States, her production being 9,146,800 short tons of crude ore, of which 3,614,200 tons was zinc-lead ore. First in rank was Arizona, with 19,038,486 tons of crude ore, mainly copper; Utah ranked next, with 14,705,718 tons of crude ore, likewise mostly copper ore. Michigan, which formerly ranked second in quantity of crude ore raised, was third in 1918, with 11,321,365 tons.

The table gives also the quantity of recoverable zinc contained in the crude ores of each State in 1918 and the quantity of zinc recoverable from each kind of ore. The percentage of recoverable zinc contained in the zinc ore and the zinc-lead ore of each State is also shown. The recoverable zinc content of crude-zinc ore ranged from 36.5 per cent for a small quantity produced in Washington down to 2.5 per cent in Tennessee; the Western States show uniformly the higher percentages. The zinc-lead ore of Illinois averaged 1.3 per cent of recoverable zinc—the leanest average shown by zinc-bearing ore worked in 1918. The zinc-lead ore of Missouri, in prior years the leanest ore mined, averaged 1.5 per cent of recoverable zinc in 1918. The average recoverable zinc content of the zinc ore of the United States in 1918 was 9.5 per cent, and of the zinc-lead ore was 3.1 per cent. Of the total mine production of zinc in 1918, a quantity corresponding to 23.5 per cent was derived from zinc ore, 76.2 per cent from zinc-lead ore, and 0.3 per cent from all other ores.

Mine production of zinc in the United States in 1918, by States and kinds of ore, in short tons.

State.	Zinc ore.			Zinc-lead ore.			All other ore.		Total.	
	Crude ore.	Recoverable zinc content.		Crude ore.	Recoverable zinc content.		Crude ore.	Recoverable zinc content.	Crude ore.	Recoverable zinc content.
		Quantity.	Percentage.		Quantity.	Percentage.				
Arizona	2,129	635	29.8	13,043	500	3.8	19,023,314	......	19,038,486	1,135
Arkansas	37,000	951	2.6	....	....	......	....	......	37,000	951
California	17,349	2,160	12.5	....	....	......	2,486,062	621	2,503,411	2,781
Colorado	60,350	11,083	18.4	291,196	32,359	11.1	1,963,344	1,125	2,314,890	44,567
Idaho	5,506	1,919	34.9	490,917	20,662	4.2	1,595,196	......	2,091,619	22,581
Illinois	....	....	......	280,900	3,792	1.3	(a)	......	[a]280,900	3,792
Kansas	....	....	......	1,025,400	30,197	2.9	....	......	1,025,400	30,197
Kentucky	[b]9,000	315	3.5	....	....	......	(a)	......	[b]9,000	315
Missouri	....	....	......	3,614,200	55,918	1.5	5,532,600	74	9,146,800	55,992
Montana	[illegible],873	100	5.3	1,090,955	104,529	9.6	6,731,139	......	7,823,967	104,629
Nevada	10,977	3,428	31.2	23,246	4,934	21.2	6,438,356	......	6,472,579	8,362
New Hampshire	....	....	......	75	14	18.7	....	......	75	14
New Jersey	672,791	98,470	14.6	....	....	......	....	......	672,791	98,470
New Mexico	110,213	9,777	8.9	13,933	2,248	16.1	4,625,638	......	4,749,784	12,025
New York	40,850	3,776	9.2	....	....	......	43	......	40,893	3,776
Oklahoma	....	....	......	5,754,700	161,401	2.8	....	......	5,754,700	161,401
Tennessee	598,742	15,234	2.5	32,217	5,837	18.1	529,012	......	1,159,971	21,071
Utah	1,849	511	27.6	428,985	8,689	2.0	14,274,884	......	14,705,718	9,200
Virginia	....	....	......	25,908	951	3.7	....	......	25,908	951
Washington	52	19	36.5	....	....	......	138,859	......	138,911	19
Wisconsin	....	....	......	2,377,300	50,014	2.1	....	......	2,377,300	50,014
	1,568,681	148,378	9.5	15,462,975	482,045	3.1	63,338,447	1,820	80,370,103	632,243
Percentage of total zinc derived from each kind of ore	....	23.5	......	....	76.2	......	....	0.3	....	100.0

[a] Exclusive of fluorspar ore.

[b] Estimated.

Districts in the United States producing more than 1,000 short tons of recoverable zinc in 1918.

District.	State.	Crude zinc-bearing ore sold or treated (short tons).	Shipping ore and concentrates (short tons).					Total recoverable zinc content (short tons).	Percentage of total production.
			Total quantity.	Sulphides.		Carbonates and silicates.			
				Quantity.	Recoverable zinc content.	Quantity.	Recoverable zinc content.		
1. Joplin	Missouri	3,614,200	113,123	95,542	50,058	17,581	5,860	55,918	8.8
	Kansas	1,025,400	55,979	55,979	30,197			30,197	4.8
	Oklahoma	5,754,700	300,727	300,702	161,393	25	8	161,401	25.5
		10,394,300	469,829	452,223	241,648	17,606	5,868	247,516	39.1
2. Butte	Montana	998,729	291,088	291,088	102,482			102,482	16.2
3. Franklin Furnace	New Jersey	672,791	533,553			533,553	98,470	98,470	15.6
4. Upper Mississippi Valley	Wisconsin	2,377,300	180,554	175,339	48,856	5,215	1,158	50,014	7.9
	Illinois	280,900	13,128	13,128	3,792			3,792	.6
		2,658,200	193,682	188,467	52,648	5,215	1,158	53,806	8.5
5. Leadville	Colorado	146,573	86,501	65,209	20,167	21,292	3,175	23,342	3.7
6. Coeur d'Alene	Idaho	485,871	56,649	56,649	21,831			21,831	3.5
7. East Tennessee	Tennessee	630,959	49,136	28,791	15,221	20,345	5,850	21,071	3.3
8. Red Cliff and Breckenridge	Colorado	114,268	58,584	58,584	15,271			15,271	2.4
9. Yellow Pine	Nevada	28,688	27,007	6,519	1,892	20,488	5,830	7,722	1.2
10. New Mexico[a]	New Mexico	80,523	21,664	19,841	5,555	1,823	365	5,920	.9
11. Magdalena	do	42,081	25,729	18,387	4,049	7,342	1,701	5,750	.9
12. Bingham and Smelter	Utah	347,275	19,588	19,588	5,580			5,580	.9
13. Edwards	New York	40,850	9,066	9,066	3,776			3,776	.6
14. Park City	Utah	47,776	4,764	4,764	1,715			1,715	.3
15. Eureka	Colorado	62,463	5,011	5,011	1,705			1,705	.3
16. Shasta County	California	92,693	16,855	16,855	1,523			1,523	.2
17. San Francisco	Utah	33,112	3,505	3,505	1,257			1,257	.2
18. Inyo County	California	14,526	5,138			5,138	1,256	1,256	.2
19. Cataract	Montana	28,482	4,497	4,497	1,232			1,232	.2
		16,920,160	1,881,846	1,249,044	497,552	632,802	123,673	621,225	98.2
All other districts								11,018	1.8
Total for United States								632,243	100.0

The districts listed in the preceding table are outlined with little heed to the artificial restrictions of political boundaries and may include parts of adjacent States. The table has been compiled to show the production of zinc in the principal districts so that they may be compared as to extent of zinc mining operations, as shown by the output of crude ore; as to character of ores, whether sulphide or oxidized; and, finally, as to relative rank as zinc producers.

COMPARISON OF PRODUCTION BASED ON SMELTER AND ON MINE REPORTS.

The figures of the smelter production of domestic primary zinc are given in the foregoing pages. The mine figures are the totals for all the States as given in part on page 1035. In order to put the smelter figures on a basis comparable with the mine figures, all the zinc manufactured into pigments directly from domestic ore is added to the metallic zinc produced. The zinc content of zinc dust ("blue powder") and of such "atomized" zinc dust as is made from metallic zinc not already taken into statistical account is also included with the metallic zinc. The zinc recovered from secondary sources is excluded, for it has already been once reckoned as zinc. Likewise the zinc in zinc oxide made from metallic zinc and the zinc content of "atomized" zinc dust made from metallic zinc already counted have been left out, as their inclusion would entail a duplication to that extent. These facts must be borne in mind in comparing the smelter totals of the subjoined table with previous tables showing the smelter production of zinc.

In compiling the mine totals each producing mine operator is requested to report actual quantity of zinc ores and concentrates shipped, and from these returns the zinc content is reckoned by assay value. From that zinc content 10 to 20 per cent, according to the character of the ore, is deducted for smelting losses, and the sum of the remainders thus obtained from all the producing properties in each State gives the total recoverable zinc for the State. Where the ore is concentrated at a custom mill, proper allowance is also made for the loss of metal in the process unless the concentrate itself has been reported.

It is clear that by either method the correctness of the totals is dependent upon complete and correct returns from each producing mine and smelter. It is essential that the smelter operator give correctly the production from domestic ore as distinguished from that made from foreign ore. It is essential to the correctness of the mine totals that the assay content and the theoretical recovery be correctly estimated. The totals, as compiled from smelter reports and from mine reports, respectively, should be in reasonable agreement. As a matter of fact, for any year they show considerable divergence. These discrepancies, recorded as "smelter excess" or "mine excess," may be the result of one cause or of a combination of causes, among which are lag in the smelting of the ore, resulting in accumulation of ore stocks at the smelters; lag in the mining, or extraordinary demand for metal, owing to which the smelter depletes its ore stocks; and error in calculating metallic content from assay and in estimating recovery.

By referring to the table comparing the mine and smelter totals it will be seen that mine excesses are more frequent than smelter excesses and that the total reported mine production of recoverable zinc for 1907–1918, inclusive, exceeds the total smelter recovery by 194,589 tons, or 3.8 per cent. This may indicate that the allowance for losses in treatment has not been large enough, but there are other possible explanations. The average zinc smelter of 1918, though the number was nearly the same as in 1908, was nearly twice as large as the average zinc smelter of 1908 and required correspondingly larger ore stocks on hand. Moreover, the number and size of zinc oxide plants has doubled in the same period, likewise requiring larger stocks of ore on hand. Furthermore, lithopone and zinc salts, formerly made from zinc ashes and other secondary material, are now made in part from zinc ore and require their proper ore stocks. It is probable that considerable quantities of zinc salts have in previous years been made from zinc ores, without statistical account being taken of the zinc so recovered. All these factors would tend to swell the total mine excess.

Domestic zinc produced by smelters and by mines, 1907–1918, in short tons.

Year.	Totals compiled from smelter reports.	Totals compiled from mine reports.	Smelter excess.	Mine excess.
1907	280,676	259,951	20,725	
1908	238,030	234,526	3,504	
1909	283,173	[a] 306,161		22,988
1910	303,139	[a] 327,618		24,479
1911	315,029	[a] 333,842		18,813
1912	386,783	[a] 385,344	1,439	
1913	408,289	[a] 413,330		5,041
1914	424,672	[a] 415,662	9,010	
1915	539,074	[a] 587,595		48,521
1916	[a] 656,875	703,317		46,442
1917	[a] 684,872	713,359		28,487
1918	597,747	632,243		34,496
	5,118,359	5,312,948		194,589

[a] Revised figures.

ZINC-REDUCTION PLANTS.

ELECTROLYTIC PLANTS.

Electrolytic zinc plants in the United States and Canada at the end of 1918.

[Exp., experimental work; Op., commercial operation.]

Company.	Location of plant.	Present daily capacity.	Development of industry.					
			1913	1914	1915	1916	1917	1918
UNITED STATES.								
American Smelting & Refining Co.	Murray, Utah	Nominal				Exp.	(a)	(b)
Do	Omaha, Nebr	do			Exp.	(b)		
Anaconda Copper Mining Co.	Anaconda, Mont	25 tons		Exp.	Op.	Op.	(a)	(a)
Do	Great Falls, Mont.	150 tons				Op.	Op.	Op.
Basin Salvage Co.	Basin, Mont	Nominal					Exp.	(b)
Bully Hill Copper Co.	Bully Hill, Calif.	do			Exp.	Exp.	(a)	(a)
Butters Electrolytic Zinc Syndicate.	Marinez, Calif	do						Exp.
Ducktown Copper, Sulphur & Iron Co. (Ltd.).	Isabella, Tenn.	1 ton					Exp.	(a)
Electrolytic Zinc Co.	Baltimore, Md	10 tons				Op.	Op.	Op.
Illinois Zinc Co.	Peru, Ill	Nominal						
Judge Mining & Smelting Co.	Park City, Utah	15 tons					Op.	Op.
Mammoth Copper Mining Co.	Kennett, Calif.	25 tons					Op.	Op.
Reed Zinc Co.	Palo Alto, Calif.	Nominal	Exp.	Exp.	Exp.	(b)		
River Smelting & Refining Co.	Keokuk, Iowa	10 tons		Exp.	Exp.	Op.	Op.	Op.
Western Chemical Manufacturing Co.	Denver, Colo	do						Exp.
CANADA.								
Consolidated Mining & Smelting Co. (Ltd.).	Trail, British Columbia.	50 tons	Exp.	Exp.	Op.	Op.	Op.	Op.
Zinc Co. (Ltd.)	Shawinigan Falls, Quebec.	5 tons			Exp.	Exp.	Op.	(a)
French Complex Ore Reduction Co.	Frank, British Columbia.	Nominal			Exp.	Exp.	Exp.	(a)

[a] Idle.

[b] Dismantled.

The output of electrolytic zinc in the United States in 1918 was 39,669 short tons, of which 38,916 tons was made from ore and 753 tons was refined from prime western metal. The output in 1917 was 26,910 tons, of which 25,209 tons was made from ore and 1,701 tons was refined from prime western metal.

The output in Canada in 1918 is shown in the table of the world's production of zinc, given on page 1061. All zinc produced in Canada is recovered by the electrolytic process.

ZINC SMELTERS.

The following table gives the zinc-smelting capacity of the United States from December 31, 1913, to December 31, 1918. This is included because of its historical value. In conjunction with the list of electrolytic zinc plants it shows in detail how the zinc-smelting industry met the extraordinary demands of the World War and how after those demands ceased it was deflated to meet the needs of reconstruction.

Zinc smelters in the United States, 1913–1918.[a]

Plants with ordinary retorts.

Operating company. (A=acid plant; not necessarily at the smelter.)	Location.	Retorts at end of 1913.	Retorts at end of 1914.	Retorts June 30, 1915.	Retorts at end of 1915.	Retorts June 30, 1916.	Retorts at end of 1916.	Retorts June 30, 1917.	Retorts at end of 1917.	Retorts June 30, 1918.	Retorts at end of 1918.
ARKANSAS.											
Arkansas Zinc & Smelting Corporation	Van Buren					2,400	3,200	3,200	3,200	3,200	3,200
Athletic Mining & Smelting Co.	Fort Smith							1,664	2,496	2,496	2,496
Fort Smith Spelter Co.	do					2,560	2,560	2,560	2,560	2,560	2,560
						4,960	5,760	7,424	8,256	8,256	8,256
COLORADO.											
United States Zinc Co.	Pueblo	1,920	1,920	2,240	2,208	1,944	1,984	2,290	1,968	2,208	2,208
ILLINOIS.											
American Zinc Co. of Illinois (A)	Hillsboro	3,200	4,000	4,000	4,000	4,864	4,864	4,864	4,864	4,864	4,864
Collinsville Zinc Smelter	Collinsville	1,536	1,536	1,536	1,792	2,304	2,304	2,300	2,304	(b)	
Eagle-Picher Lead Co. (A)	Hillsboro	1,840	1,840	1,840	1,840	3,200	3,200	3,200	3,200	3,200	3,200
Granby Mining & Smelting Co. (A)	East St. Louis			1,620	3,220	3,220	4,820	5,620	5,620	5,620	5,620
Hegeler Zinc Co. (A)	Danville	1,800	1,800	3,600	3,600	5,400	5,400	5,400	5,400	5,400	5,400
Illinois Zinc Co. (A)	Peru	4,640	4,640	4,640	4,640	4,640	4,640	5,440	5,440	5,520	5,520
Matthiessen & Hegeler Zinc Co. (A)	La Salle	5,256	5,256	6,168	6,168	6,168	6,168	6,168	6,168	6,168	6,168
Missouri Zinc Co.	Beckemeyer	192	192	192	352	352	352	302	352	352	352
Mineral Point Zinc Co. (A)	Depue	6,800	9,080	9,068	9,068	9,068	9,068	9,068	9,068	9,068	9,068
National Zinc Co. (A)	Springfield	3,200	3,200	3,200	3,200	4,480	4,480	4,480	4,480	4,480	4,480
Sandoval Zinc Co.	Sandoval	996	996		672	672	672	672	672	672	672
		29,460	32,540	35,864	38,552	44,368	45,968	47,514	47,568	45,344	45,344
INDIANA.											
Grasselli Chemical Co. (A)	Terre Haute								3,360	4,200	4,200
KANSAS.											
American Spelter Co.	Pittsburg				896	992	992	992	992	(c)	
American Zinc, Lead & Smelting Co.	Caney	3,648	3,648	4,596	6,080	6,080	6,080	6,080	6,080	6,080	4,352
Do.	Dearing	3,840	3,840	4,480	4,480	4,480	4,480	4,480	4,480	(c)	
Chanute Spelter Co.	Chanute	1,280	1,280	1,280	1,280	1,280	1,280	1,280	(c)		
Cherokee Smelting Co.	Bruce			896	896	896	896	896	896	(c)	

[a] Includes distillation plants working on ore alone, on ore and drosses, and on drosses alone.

[b] Idle.

[c] Dismantled.

Zinc smelters in the United States, 1913–1918—Continued.

Plants with ordinary retorts—Continued.

Operating company. (A=acid plant; not necessarily at the smelter.)	Location.	Retorts at end of 1913.	Retorts at end of 1914.	Retorts June 30, 1915.	Retorts at end of 1915.	Retorts June 30, 1916.	Retorts at end of 1916.	Retorts June 30, 1917.	Retorts at end of 1917.	Retorts June 30, 1918.	Retorts at end of 1918.
KANSAS—continued.											
Edgar Zinc Co.	Cherryvale	4,800	4,800	4,800	4,800	4,800	4,800	5,040	5,040	5,040	4,984
Granby Mining & Smelting Co.	Neodesha	3,760	3,760	3,760	3,760	3,760	3,760	3,760	3,760	(a)	....
Iola Zinc Co.	Concrete	....	....	....	660	1,320	1,320	1,320	(a)	....	....
Joplin Ore & Spelter Corporation	Pittsburg	....	....	1,120	1,444	1,792	1,792	1,992	1,992	(a)	....
Lanyon Smelting Co.	do	....	....	....	448	448	448	448	448	(a)	....
Owen Zinc Co.	Caney	....	....	....	1,280	1,280	1,920	1,920	1,920	1,920	(b)
Pittsburg Zinc Co.	Pittsburg	910	910	896	910	910	910	910	910	(b)	....
Prime Western Spelter Co.	Iola	2,598	2,598	2,698	2,698	2,698	2,698	2,696	2,696	1,972	2,320
Do. (A)	Gas	2,170	2,170	2,170	2,170	2,170	2,170	2,170	2,170	(a)	....
United States Smelting Co.	Altoona	3,960	3,960	3,960	3,960	4,600	4,600	4,600	(a)	....	....
Do.	Iola	....	....	1,400	3,440	3,440	3,440	3,440	3,440	(a)	....
Do.	La Harpe	1,856	1,856	....	1,924	1,924	1,926	1,926	(a)	....	....
Weir Smelting Co.	Weir	....	....	....	....	....	288	448	448	(b)	....
		28,822	28,822	32,056	41,126	42,870	43,800	44,398	35,272	15,012	11,656
MISSOURI.											
Edgar Zinc Co.	St. Louis	2,000	1,100	2,000	2,000	2,000	2,000	1,982	1,982	1,982	(a)
Missouri Zinc Smelting Co.	Rich Hill	....	....	....	....	448	448	448	448	(b)	....
Nevada Smelting Co.	Nevada	672	....	....	672	672	672	672	672	(b)	....
		2,672	1,100	2,000	2,672	3,120	3,120	3,102	3,102	1,982	....
OKLAHOMA.											
Bartlesville Zinc Co.	Bartlesville	5,184	5,184	5,184	5,184	6,336	6,336	6,336	6,336	5,184	5,184
Do.	Blackwell	....	....	....	....	1,600	9,600	9,600	9,600	9,600	9,600
Do.	Collinsville	8,064	8,064	8,064	10,752	13,440	13,440	13,440	13,440	(a)	....
Bartlesville Zinc Co. (Lanyon-Starr plant)	Bartlesville	3,456	3,456	3,456	3,456	3,456	3,456	3,456	3,456	3,456	3,456
Eagle-Picher Lead Co.	Henryetta	....	....	....	....	....	4,000	4,000	4,000	4,000	4,000
Kusa Spelter Co.	Kusa	....	....	....	3,720	7,720	7,720	7,720	7,720	5,600	5,360
National Zinc Co.	Bartlesville	4,480	4,260	4,970	4,970	4,970	4,970	4,970	4,970	4,256	4,160
Oklahoma Spelter Co.	Kusa	....	....	....	....	1,600	1,600	1,600	1,600	(b)	....
Quinton Spelter Co.	Quinton	....	....	....	....	....	1,344	2,016	2,016	2,016	2,016
Tulsa Fuel & Manufacturing Co.	Collinsville	6,232	6,232	6,232	6,232	6,232	6,232	6,232	6,232	6,232	6,232
United States Smelting Co.	Checotah	....	....	....	....	2,560	5,120	5,120	5,120	5,120	5,120
United States Zinc Co.	Sand Springs	....	2,400	4,800	5,680	8,000	8,000	10,902	8,000	8,360	5,936

Victory Metal Co.	Henryetta	....	....	....	....	3,000	3,000	3,000	3,000	3,000	3,000
Western Spelter Co.	do	....	....	....	....	....	2,400	....	2,648	2,648	3,200
		27,416	29,596	32,706	39,994	58,914	77,218	78,482	78,138	59,472	57,264
PENNSYLVANIA.											
American Steel & Wire Co. (A)	Donora	....	....	....	3,648	9,120	9,120	9,120	9,120	9,120	9,120
American Zinc & Chemical Co. (A)	Langeloth	....	880	3,648	3,648	6,384	7,296	7,296	7,296	7,296	7,296
New Jersey Zinc Co. (of Pennsylvania)	Palmerton	5,760	5,760	6,720	6,720	6,960	7,200	7,200	7,200	7,200	7,192
		5,760	6,640	10,368	14,016	22,464	23,616	23,616	23,616	23,616	23,608
WEST VIRGINIA.											
Clarksburg Zinc Co.	Clarksburg	2,736	1,824	2,736	3,648	3,648	3,648	3,648	3,648	(b)	....
Grasselli Chemical Co. (A)	do	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760
Do	Meadowbrook	6,912	6,912	6,912	8,592	8,592	8,544	8,544	8,544	8,520	8,520
United Zinc Smelting Corporation (A)	Moundsville	....	....	....	....	....	....	....	1,728	1,728	1,728
		15,408	14,496	15,408	18,000	18,000	17,952	17,952	19,680	16,008	16,008
Total retorts	....	111,458	115,114	130,642	156,568	196,640	219,418	224,778	220,960	176,098	168,544
Retorts in operation	....	85,000	94,500	129,000	155,000	177,500	204,500	189,500	132,750	107,500	123,500

Plants with large retorts.[c]

Eastern Zinc Refining Co.	Brooklyn, N. Y.	....	....	....	....	....	8	....	16	....	16
John Finn Metal Works	San Francisco, Calif.	....	....	....	....	....	2	....	2	....	12
Michael Hayman & Co.	Buffalo, N. Y.	12	12	....	12	....	12	....	12	....	12
M. M. S. Metal Co.	Trenton, N. J.	....	....	....	....	....	21	....	21	....	(a)
Trenton Smelting & Refining Co.	do	40	40	....	96	....	96	....	60	....	80
William Cramp & Sons Ship & Engine Building Co.	Philadelphia, Pa.	24	24	....	32	....	32	....	32	....	(a)
Joseph G. Kessler & Co.	Brooklyn, N. Y.	....	....	....	....	....	....	....	....	....	8
		76	76	....	140	....	171	....	143	....	128

[a] Dismantled.

[b] Idle.

[c] Large graphite retorts, yielding 600–800 pounds of zinc per charge.

NOTE.—The Grasselli Chemical Co. operates acid plants in connection with its zinc-roasting furnaces at Terre Haute and Grasselli, Ind.; Cleveland, Canton, and Lockland (near Cincinnati), Ohio; and Newcastle, Pa., and smelts the roasted zinc concentrates at the smelters at Terre Haute, Ind., and Clarksburg and Meadowbrook, W. Va. The Prime Western Spelter Co. operates roasting furnaces and an acid plant at Tiltonsville, Ohio. The National Zinc Co. has roasting furnaces and an acid plant at Argentine, Kans.

The foregoing lists include a few retort smelters that treat only secondary materials, such as zinc ashes, skimmings, and galvanizers' drosses; also a few that recover about equal quantities of zinc from ores and from secondary materials, as well as several more that treat minor quantities of secondary materials. Several other zinc-smelting plants in the country obtain zinc by the distillation of zinc ashes and drosses in large graphite crucibles and condensers somewhat similar to those used in the Faber du Faur furnaces for recovering zinc from the zinc crusts in lead desilverization. These are given at the bottom of the list.

ZINC-SMELTING CAPACITY AND CHANGES IN 1918.

The number of retorts at zinc smelters at the end of 1918 was 168,544. There were no additional retorts under construction; in fact, at several smelters it was intended to discontinue operations after the end of the year. This did not involve dismantling the plants, however. The number of retorts in operation was 123,500 at 36 plants compared with 107,500 retorts in operation at the middle of 1918 and with 132,750 retorts in operation at 54 plants at the beginning of 1918.

THE ZINC INDUSTRY AND THE WORLD WAR.

Below is given a brief account of the war's demands upon the zinc industry and of the ways in which the industry met these demands. From the American's point of view the war is naturally divided into two periods—that before the United States became involved as an ally and that afterward.

FIRST PERIOD.

In the first period the part of this country was to furnish the greatly increased supplies of zinc demanded for war uses by the Allies. This burden fell upon the United States because of the fact that of the three main zinc-smelting centers in Europe two were in Germany and the other was along Meuse River in the line of the German advance through Belgium and northern France.

The demand for zinc made itself felt immediately after the war broke out, and exports of zinc for the last five months of 1914 reached unprecedented quantities; yet the price did not reflect this demand, because very large smelter stocks were on hand at the middle of the year—about 65,000 tons—almost equal to the exports for the last half of the year. As a result, after the preliminary upward flurry at the beginning of the war, the price dropped in October, 1914, to the lowest point of the whole war period, 4.6 cents a pound. The great demand continued, however, and after the stocks were exhausted the price rose rapidly to the highest point of the war, reaching 26.5 cents a pound for prime western zinc early in June, 1915. The rising prices had encouraged such a fever of new zinc-smelter building and of enlarging and rebuilding old plants that in the first half of 1916 the smelter capacity and production had overtaken the consumption and stocks had begun to accumulate. One reason for the culmination of the extremely high prices in 1915 was that the different

Allies bought their munitions individually in the United States and naturally came into competition and thus bid the prices up on one another. In January, 1915, the British Government appointed J. P. Morgan & Co. as purchasing agents for copper, zinc, brass, and other munitions exclusive of pig lead, and in May of the same year the French Government did likewise. The stopping of active competition between these two of the largest buyers of zinc as metal and in munitions was followed by a sharp decline in prices, beginning in the last half of June and eventually in August reaching 11 cents a pound. Afterward, however, the temporary scarcity of zinc, owing to greater war demands, carried the price up to slightly over 19 cents a pound in February, 1916. At this point the accumulation of zinc stocks made itself felt, and zinc dropped to 8.8 cents a pound and has never since, except for two periods of a month or so each, commanded more than 10 cents a pound.

The Geological Survey's new-year, mid-year, advance, and annual statements of zinc production were published as usual during this period, but they were considerably more detailed than previous statements. A statement published in August, 1914, discussed the general zinc situation as affected by the war, giving the prewar exports of zinc and galvanized iron from Germany, Belgium, France, and Great Britain, and the imports of zinc and galvanized iron into South America, and pointing out that the war, by tying up the European zinc centers, offered the United States a chance to enter the zinc markets of the world. In April, 1915, the resources, production, and consumption of zinc were discussed and the conclusion reached that the zinc resources, smelting capacity, and production of the United States were fully equal to any probable demand. In April, 1916, attention was called to the great increase in smelting capacity and to the danger of overbuilding. However, smelter building continued apace until on June 30, 1917, there were 224,778 ordinary retorts in this country, in addition to the large retorts working on secondary materials and to the electrolytic plants. In 1916 and 1917 the maximum production of zinc was recorded. The story thereafter is one of declining prices and the closing and dismantling of plants.

SECOND PERIOD.

WORK OF ORGANIZATIONS.

During the first period the high prices and great demand for zinc, especially for the higher grades, had stimulated smelter building so that by the time the United States entered the war the capacity was more than equal to any demand that was likely to be made upon it. However, zinc was naturally dealt with as the other metals entering into munitions, and committees, including representative zinc producers, cooperated with the Government war boards and commissions, not that production might be stimulated but that wasteful overproduction might be avoided and that zinc might be substituted where possible for other needed but scarcer metals. The Joint Information Board, composed of representatives of the Government bureaus and the war boards and commissions, maintained the contact between them necessary to prevent duplication of effort and loss of time. Excerpts and summaries of the reports of the zinc producers' committees and the War Industries Board are given on pages 1049–1052.

UNITED STATES GEOLOGICAL SURVEY.

During the second period the United States Geological Survey collected weekly by wire statistics of the production, stocks, and commitments of zinc in the different grades and furnished them to the War Industries Board. This service was begun in November, 1917, and continued until the end of the war. Permission of producers to publish the weekly totals of production and stocks by grades was obtained, and these reports were distributed to the press, beginning with the week ending July 26, 1918. Quarterly reports of zinc production had been published during the last half of 1917 and were continued through 1918.

In requesting permission to publish the weekly reports it was urged upon the zinc producers that the weekly publication of production and stocks by grades would tend to stabilize prices and production by putting the status of the zinc industry clearly before producer and consumer each week. As the Government was the chief consumer and as these reports had already been made to the Government for more than eight months, it was urged that any advantage which consumers would gain would be more than offset by the advantage gained by the producer. The effect of the publication of these figures may be seen from the accompanying curves (fig. 18), showing the weekly production and stocks of each grade for the period for which they were collected. Any stabilizing effect, of course, would be manifested only after publication was begun at the end of July. The excess of supply over production for all grades except grade A is shown graphically. The limitation of output of grade D zinc through the second and third quarters of 1918, which accomplished the remarkable reduction in stocks, is likewise shown, together with the correlated rise in price. To a certain extent the same is true of grade C zinc. In the early part of 1918 the output and weekly stocks of grade A metal were small, but later, through increase of redistillation and electrolytic plants, the output increased and the stocks were materially augmented. After the armistice was declared the demand for zinc lessened and the output of grades C and D was somewhat larger, resulting in increase of stocks and declining prices for zinc. The chart brings out in a striking way the enormous visible zinc supplies in the early part of 1918 and also in the early part of 1919. Publication of the weekly statistics was urged under the plea that such data would be essential to proper measures for reorganization and reconstruction of the zinc industry. Several smelters refused to carry longer the burden of weekly reports, however, and publication was discontinued with the issue of January 25, 1919. Figures were nevertheless collected for the weeks ending February 22 and March 22 for the use at conferences of the zinc producers' committee and the director of sales, purchase, storage, and traffic division of the War Department called to consider the question of disposal of Government surplus zinc. The statistics for these weeks do not include Government-owned stocks at smelters, amounting to approximately 10,000 tons. If this zinc is added to

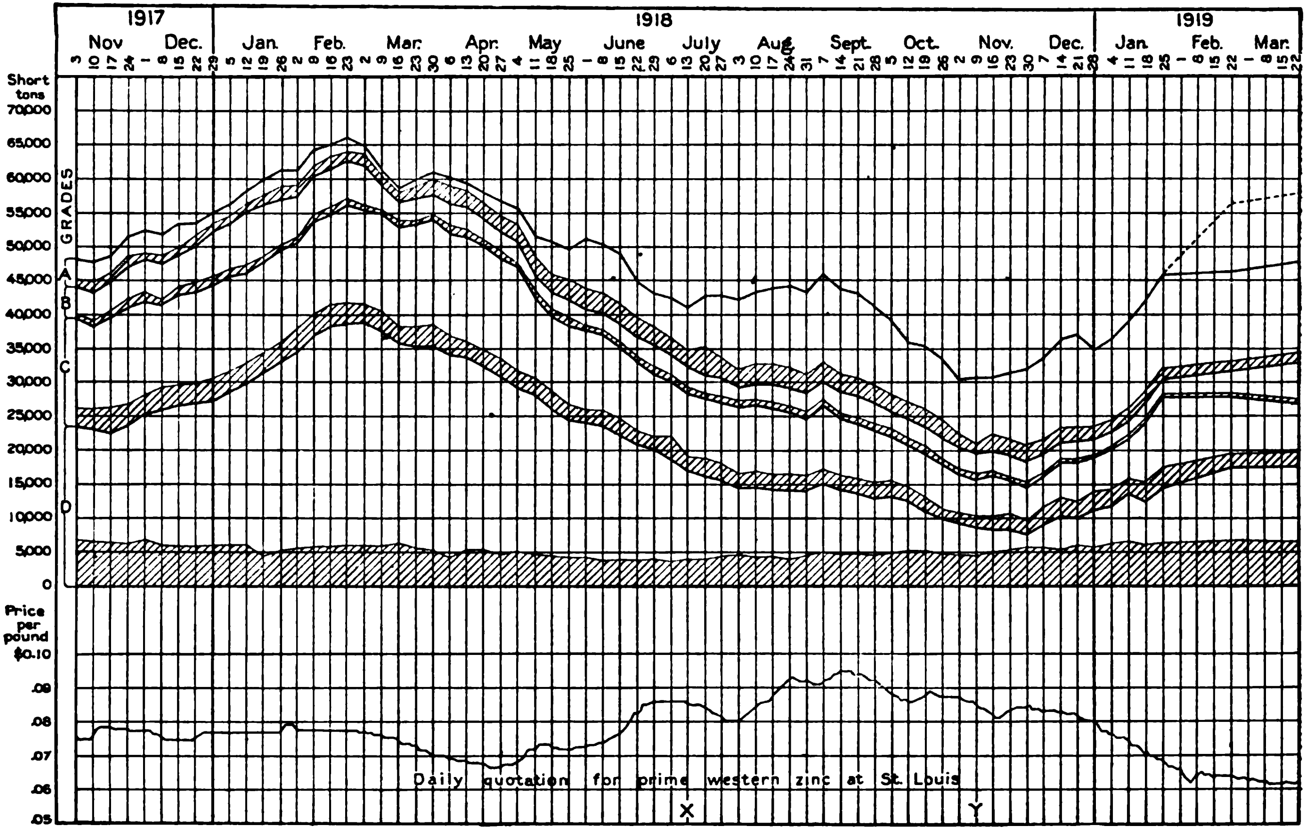

FIGURE 18.—Curves showing the weekly production and stocks of zinc by grades with daily market quotations for prime western zinc at St. Louis, November, 1917, to March, 1919. The whole space between the heavy lines represents stocks of zinc by grades as lettered at the end of the week. The upper solid line therefore represents the total supply of zinc at smelters at the week ends. The shaded areas represent weekly production of zinc by grades. The broken line shown in February and March, 1919, represents the addition of stocks of Government-owned zinc not reported by smelters for those weeks. "X" shows beginning of publication of weekly reports of production and stocks, and "Y" shows the signing of the armistice.

that given it will be seen that stocks increased nearly 3,000 tons a week from December 28, 1918, to March 22, 1919. The Government-owned stocks are shown by the broken line at the top of the curve for February and March, 1919.

WAR SERVICE COMMITTEES ON ZINC.

The following notes on the services of the committees on zinc formed at the instance of the Council of National Defense are summarized from a history of the committees by Edgar Palmer, chairman, made to the historical division of the General Staff, United States Army.

ADVISORY COMMITTEE ON ZINC.

In the later part of March, 1917, shortly before the United States entered the war, Bernard Baruch, chairman of the committee on raw materials, minerals, and metals of the Council of National Defense, asked Edgar Palmer, president of the New Jersey Zinc Co., to accept the chairmanship of the advisory committee on zinc. After the official notification and acceptance of the chairmanship on April 21, 1917, the following additional members of the committee were appointed by Mr. Baruch:

Charles W. Baker, American Zinc, Lead & Smelting Co.
Sidney J. Jennings, United States Smelting, Refining & Mining Co.
Thomas F. Noon, Illinois Zinc Co.
N. Bruce MacKelvie, Butte & Superior Mining Co.
Charles T. Orr, Bertha A. Mining Co.
Cornelius F. Kelley, Anaconda Copper Mining Co.
A. P. Cobb (secretary), New Jersey Zinc Co.

Among the first duties of the committee were to ascertain the immediate needs for zinc and to obtain an estimate of the future requirements. As the purchases of zinc involved many bureaus, boards, producers, and consignees, a scheme governing the placement, billing, and allocation of shipments was devised, known as the routine flow sheet, through which, by means of a checking system of manifold filing of orders, acknowledgments, and shipping directions with all parties concerned, business was simplified and all were kept in touch with the progress made on each order.

About the middle of April the Government was in urgent need of about 10,000 tons of grade A and grade B zinc, and a few hundred tons of grade C zinc. Through the committee this was furnished at 11½ cents a pound for grade A, 11 cents a pound for grade B, and 9 cents a pound for grade C, although grade A zinc was then selling in open market for 25 cents a pound and the other grades in proportion.

The announcement of this first purchase of zinc through the committee resulted shortly in published rumors that the price of grade C zinc had been fixed at 9 cents a pound. As this is the grade of zinc most largely produced from Joplin concentrates, which yield approximately 40 per cent of the zinc output of the country, and as the price of 9 cents was admittedly below the cost of producing metal from Joplin concentrates at the then current price of $85 a ton, it was urged that the price of Joplin concentrates would necessarily be reduced, resulting in curtailment of production in that important district.

Furthermore, a number of producers had refused to offer to furnish any part of the first requirement of 10,000 tons because the prices fixed were alleged to be below the current costs of production. Therefore the committee proposed a new schedule of prices, for June-September delivery, based on Joplin concentrates at $85, as follows: Grade A, 15 cents; grade B, 14 cents; brass special, 13 cents; and grade C, 12 cents—these prices being urged in order to maintain a maximum output of Joplin concentrates.

The Government through the War and Navy Departments having made objection to these prices, a temporary schedule was arranged in order that supplies might go forward, final adjustments to be made later. These temporary prices were: Grade A, 13½ cents; grade B, 13 cents; grade C, 8¾ to 9 cents. In August the committee was asked to obtain for the Navy Department and the Emergency Fleet Corporation 5,000 tons of grade A zinc at 12½ cents and 1,375 tons of grade B zinc at 12 cents. In September this request was countermanded and the zinc was obtained by the organizations concerned in the regular way by asking for bids.

In June, 1917, the committee asked for offers to supply about 2,000 tons of zinc sheets at 16 cents and several hundred tons of zinc plates at 15 cents. In July the Navy Department asked for an additional 2,500 tons of plates at 14 cents. On the representation of producers that this would be unremunerative, the price was set at 15 cents.

After the passage of the food and fuel control act in August, 1917, the committee on zinc resigned, because that act prohibited those who sold material to the Government from serving on such committees.

ZINC PRODUCERS' COMMITTEE.

In November, 1917, the War Industries Board suggested the formation of a zinc producers' committee to act in an intermediary capacity between the producers and the War Industries Board. The following persons were named:

Edgar Palmer (chairman), New Jersey Zinc Co.
C. M. Loeb, American Metal Co.
C. F. Kelley, Anaconda Copper Mining Co.
Sidney J. Jennings, United States Smelting Co.
E. W. Furst, Grasselli Chemical Co.
W. A. Ogg, American Zinc, Lead & Smelting Co.
S. M. Evans, Eagle-Picher Lead Co.
J. D. Layng, jr., Illinois Zinc Co.
W. W. Vick, Henryetta Spelter Co.
N. B. MacKelvie, Butte & Superior Mining Co.
A. P. Cobb, Mineral Point Zinc Co.
C. T. Orr, Athletic Mining & Smelting Co.

A traffic subcommittee of three was appointed and its chairman represented the zinc producers on the traffic committee of copper, lead, and zinc producers, in negotiations with the Railroad Administration and Government departments in transportation matters.

At the request of Pope Yeatman, who succeeded Eugene L. Meyer as chief of the nonferrous metals section of the War Industries Board, the committee gave considerable time to the question of the variation in value between prime western zinc and Joplin concentrates. At a conference of the committee with the zinc-ore producers of the Joplin district a schedule was adopted with a sliding scale of prices for Joplin concentrates based on the grade of the concentrates and on the average quotation for prime western zinc for the week previous. Before the plan could be thoroughly tested the armistice was declared and the agreement lapsed.

[A copy of the sliding scale is given below. This scale was worked out on an assumed cost of $58 a ton for mining and concentrating and of $33 for smelting.]

Plan governing the purchase and the sale of Joplin blende ore, adopted at a conference between the zinc producers' committee and the Joplin ore producers on October 18, 1918.

1. That the smelters will specify the quantity of ore that they will obligate themselves to take in approximately equal weekly quantities during the period ending January 1, 1919, and that the ore producers will furnish such tonnage, both subject to fires, strikes, accidents, or other causes beyond the control of either party, interrupting, curtailing, or suspending operations at smelters or mines, and neither party shall be liable for damages due to such interruption, curtailment, or suspension.

2. That the ratio shown in the following table shall be the basis of the settlement for 60 per cent zinc Joplin mill concentrates, subject to the variation of $1 for each unit above or below 60 per cent zinc contents, and subject to the customary lime and iron penalties of $1 for each unit of these ingredients in excess of 1 per cent. Sludge material running not below 57½ per cent zinc shall be penalized $2.50 per ton; sludge material assaying less than 57½ per cent zinc and all flotation material shall be penalized $5 per ton. This schedule shall not apply to any ores below 50 per cent zinc.

Spelter market (in cents).	Ratio.	Price, 60 per cent Joplin ore at mines.
6.0	6.80 to 1	$40.800
6.1	6.79 to 1	41.419
6.2	6.78 to 1	42.036
6.3	6.77 to 1	42.651
6.4	6.76 to 1	43.264
6.5	6.75 to 1	43.875
6.6	6.74 to 1	44.484
6.7	6.73 to 1	45.091
6.8	6.72 to 1	45.696
6.9	6.71 to 1	46.299
7.0	6.70 to 1	46.900
7.1	6.69 to 1	47.499
7.2	6.68 to 1	48.096
7.3	6.67 to 1	48.691
7.4	6.66 to 1	49.284
7.5	6.65 to 1	49.875
7.6	6.64 to 1	50.464
7.7	6.63 to 1	51.051
7.8	6.62 to 1	51.636
7.9	6.61 to 1	52.219
8.0	6.60 to 1	52.800
8.1	6.59 to 1	53.379
8.2	6.58 to 1	53.956
8.3	6.57 to 1	54.531
8.4	6.56 to 1	55.104
8.5	6.55 to 1	55.675
8.6	6.54 to 1	56.244
8.7	6.53 to 1	56.811
8.8	6.52 to 1	57.376
8.9	6.51 to 1	57.939
9.0	6.50 to 1	58.500
9.1	6.49 to 1	59.059
9.2	6.48 to 1	59.616
9.3	6.47 to 1	60.171
9.4	6.46 to 1	60.724
9.5	6.45 to 1	61.275
9.6	6.44 to 1	61.824
9.7	6.43 to 1	62.371
9.8	6.42 to 1	62.916
9.9	6.41 to 1	63.459
10.0	6.40 to 1	64.000
10.1	6.39 to 1	64.539
10.2	6.38 to 1	65.076
10.3	6.37 to 1	65.611
10.4	6.36 to 1	66.144
10.5	6.35 to 1	66.675
10.6	6.34 to 1	67.204
10.7	6.33 to 1	67.731
10.8	6.32 to 1	68.256
10.9	6.31 to 1	68.779
11.0	6.30 to 1	69.300
11.1	6.29 to 1	69.819
11.2	6.28 to 1	70.336
11.3	6.27 to 1	70.851
11.4	6.26 to 1	71.364
11.5	6.25 to 1	71.875
11.6	6.24 to 1	72.384
11.7	6.23 to 1	72.891
11.8	6.22 to 1	73.396
11.9	6.21 to 1	73.899
12.0	6.20 to 1	74.400
12.1	6.19 to 1	74.899
12.2	6.18 to 1	75.396
12.3	6.17 to 1	75.891
12.4	6.16 to 1	76.384
12.5	6.15 to 1	76.875
12.6	6.14 to 1	77.364
12.7	6.13 to 1	77.851
12.8	6.12 to 1	78.336
12.9	6.11 to 1	78.819
13.0	6.10 to 1	79.300
13.1	6.09 to 1	79.779
13.2	6.08 to 1	80.256
13.3	6.07 to 1	80.731
13.4	6.06 to 1	81.204
13.5	6.05 to 1	81.675
13.6	6.04 to 1	82.144
13.7	6.03 to 1	82.611
13.8	6.02 to 1	83.076
13.9	6.01 to 1	83.539
14.0	6.00 to 1	84.000
14.1	5.99 to 1	84.459
14.2	5.98 to 1	84.916
14.3	5.97 to 1	85.371
14.4	5.96 to 1	85.824
14.5	5.95 to 1	86.275
14.6	5.94 to 1	86.724
14.7	5.93 to 1	87.171
14.8	5.92 to 1	87.616
14.9	5.91 to 1	88.059
15.0	5.90 to 1	88.500

3. The market price of spelter governing settlements will be posted by the Joplin Ore Producers Association each Friday and shall govern for one week. The quotation to be posted by the Joplin Ore Producers Association shall be the average of the daily quotations for prime western spelter at St. Louis as given in the Engineering and Mining Journal for the week ending the Wednesday previous to the Friday of the week in which the quotation is posted.

4. Should this arrangement prove satisfactory, it will be continued from quarter year to quarter year, with such modifications as may be found necessary.

UNITED STATES WAR INDUSTRIES BOARD.

The nonferrous metals section of the War Industries Board from its inception bore a vital relation to the war metal industries. The operations of the section are briefly described in a report from which the paragraphs relating to zinc are given below.[1]

Organization.—The nonferrous metals section was organized in October, 1917, with Mr. Eugene M. Meyer, jr., as section chief. He was assisted by Messrs. O. F. Weber, H. G. Moulton, and E. M. Friedman, and later by Mr. Pope Yeatman. In March,

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[1] Report on the activities of the section of nonferrous metals, United States War Industries Board, Dec. 31, 1918.

1918, Mr. Meyer transferred his activities to a directorship in the War Finance Corporation, and Mr. Yeatman was made section chief. In October, 1918, Mr. Yeatman's title was changed to "Director," and the personnel under him has included E. Coppee Thurston, assistant; Irwin H. Cornell, in charge of lead; George C. Stone, in charge of zinc; Andrew Walz, assistant; and Lieut. H. R. Aldrich, statistician.

The metals handled by this section under Mr. Yeatman are aluminum, antimony, copper, lead, nickel, quicksilver, and zinc. The duty of this section has been to ascertain the requirements of the American and Allied Governments, and the essential commercial needs of the country in these raw materials, and when necessary to encourage an increase in their production. It has been the aim to interfere as little as possible with the normal course of business, and to have the producers, importers, dealers, and consumers feel that it was the section's desire to understand and help them in their difficulties, and it is pleasant to record the almost universal and hearty spirit of cooperation in the industries.

Production.—At the time the United States entered the war there was an ample supply of common spelter and practically sufficient of the high grade. The situation regarding the latter was eased by persuading the Army to make its specifications more liberal as regards cadmium, and there has not been any shortage for either war purposes or ordinary industrial purposes, though the high price due to high labor and fuel costs has restricted some industrial uses.

Causes of shortage.—There was no shortage in zinc metal, but lack of rolling mill capacity limited the production of sheet zinc.

Embargoes.—Export embargoes: All of the metals handled by this section, except zinc, were on the War Trade Board's export conservation list, for which individual licenses were required for shipment.

Prices.—Government prices before fixing: Early in 1917 a zinc committee was appointed to arrange a price for Government purchases, but before an agreement was reached the market price sank below the figures discussed, so no arrangement was made.

Prices fixed by the price-fixing committee: On February 13, 1918, a maximum price on grade A of 12 cents per pound f. o. b. East St. Louis, and maximum base prices on plate zinc of 14 cents and on sheet zinc of 15 cents f. o. b. plant, subject to the usual trade discounts and differentials, were fixed until June 1, 1918. Before the end of May these prices were extended to the 1st of September, and prior to that date they were again extended to January 1, 1919, when they will expire by limitation.

Present trend of prices: The price is now very low and is decreasing from week to week with every indication that it will continue to fall.

Methods of control.—No control was necessary, but a zinc producers' committee was formed in September, 1917, to assist in bringing about better relations between the miners and the smelters.

Methods of purchase.—Purchases were made direct either by negotiation or by requests for competitive bids.

Arrangements made in the industry.—After the maximum price had been fixed on sheet and plate zinc and in order to encourage additional output and help the underpaid mining companies, it was suggested to the zinc rolling mills by the mine operators that they should pay the miners $75 per ton base on 60 per cent zinc concentrates running under a certain percentage of lead, and buy their requirements from all the mines of the Joplin district that produced this grade of ore proportionately. This was accepted, and the High-Grade Ore Producers' Association was formed among these miners. This section then appointed a high-grade ore producers' allocating committee to receive the requirements of the rolling mills and allocate them proportionately to the various members of the association.

An effort was made to assist the Joplin district zinc miners by an arrangement whereby all the producers of the Joplin district were to agree with all the zinc smelters for a sliding scale of prices dependent upon grade. This scheme, however, fell through because the American Metal Co., which is one of the largest buyers, withdrew after having entered the agreement, while the Edgar Zinc Co. and one or two other small companies never came in.

Conservation effected.—When the war ended considerable conservation was in course of being effected by the substitution of sheet zinc for tin plate, galvanized sheet, sheet aluminum, and nickel plate. It is hoped that some of these uses for sheet zinc will continue after the war.

Some conservation of lead was also effected in August and September, 1918, when lead became very scarce, by the use of zinc metal, as in the coffin industry.

High-grade or grade A zinc, for making cartridge cases, was at first purchased solely on the Navy specifications, which were very stringent. The zinc producers and this section, after studying the question, advised the War Department to make its own specifications for grade A less stringent as to cadmium content than those of the Navy. This was done and resulted in many zinc smelters making Army grade A zinc by redistillation, thus affording another outlet for some of the excess production of zinc of the lower grades.

New capacity.—Early in the war, before the participation of the United States, there was a very great increase in the demand for spelter, mainly for export, which was met in three ways—by increasing existing plants, by reopening abandoned and obsolete plants, and by the construction of new plants.

By the time the United States entered the war, the smelting capacity was more than ample to supply all requirements. To meet the demand for high-grade spelter, special furnaces were built or old ones were altered to refine lower grade spelter. These will be a total loss, except in a few cases where they can be altered to regular smelting furnaces. The present smelting capacity is about twice the normal demand and the present output about 50 per cent greater than the normal. Much of the present active capacity is new construction, as the poorest plants have been forced out of business. Many more plants will be obliged to close down unless the export demand proves to be very large.

Present outlook.—The increase in the production of zinc on account of the war has been relatively greater than that of any other metal. The production in 1907 was 59 per cent greater than that of 1902; that of 1912, 35 per cent greater than 1907; and that of 1917, 97 per cent greater than 1912; and the greater part of the abnormal increase has been in high grade. The stocks in the hands of smelters and the Government are exceedingly large, and the causes that have decreased its use for galvanizing during the war will in part persist. The next largest use, which is for brass and other alloys, will also probably be decreased by the large amounts of scrap brass that are likely to come on the market.

Much zinc will be needed for reconstruction, but the English works have been much increased and will doubtless take care of part of this. Further, much of the zinc required will be in the form of sheet, and our rolling mill capacity is quite limited. The present spelter output is at least 50 per cent greater than the probable home demand, and many works will be obliged to shut down as it is not economical to run at a small fraction of capacity. At present there are 21 plants producing spelter of which not over one-third can be called strong, and at least an equal proportion are decidedly weak.

Outside of the smelters the most serious effect will be in the Joplin mining fields as its ore is always sold weekly for immediate delivery, while in the other districts the ore is sold almost entirely on long-term contracts or the mines are owned by the smelters.

AMERICAN ZINC INSTITUTE.

The American Zinc Institute was organized July 29, 1918, when the first meeting was held at St. Louis, Mo. The institute is composed of miners, smelters, and manufacturers of zinc. Though organized with a view to benefit the industry under peace-time conditions, nevertheless it brought together the principal zinc producers of the country at the height of the war and gave opportunity for full discussion of the conditions confronting the entire industry. The special incentive to organization lay in the extremely low prices of zinc in April, 1918, the lowest since the early part of 1915. The immediate problem was not so much one of speeding up production, as it was in other metal industries, but rather one of action to prevent overproduction and consequent depression and disorganization of the industry, which might result in scarcity at the most critical period of the war. Smelter stocks of about 53,700 tons at the beginning of 1918 had been reduced to 44,500 tons by the middle of the year, and conditions were therefore somewhat more satisfactory at the time of organization.

Among the policies of the institute are to obtain the widest possible use of zinc products by means of research and publicity, to promote a better knowledge of foreign output and resources through the operation of a statistical bureau, and to promote efficiency and progress in the industry through scientific research and mutual exchange of data.

The institute held itself at the service of the Government at all times, and after the armistice was declared it helped to formulate plans for the disposal of the surplus of Government-owned zinc to the least injury of the industry.

The address is American Zinc Institute (Inc.), Stephen S. Tuthill, Secretary, 27 Cedar Street, New York City.

WAR EXPORTS OF ZINC.

The following tables bring together the quantity and value of the exports of zinc and manufactures of zinc for the period of the war. As these tables have been published in this form only during the war, they are given here to round out the foregoing account of the war relations of the zinc industry. For the greater part they are not duplicated elsewhere in this chapter.

Zinc exported from the United States, 1914–1918, by classes.

Material.	1914		1915		1916		1917		1918	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
DOMESTIC.										
Zinc ore	22,220,800	$388,464	1,664,320	$35,276	156,800	$3,992	2,640,960	$63,043	123,000	$2,480
Zinc slabs and sheets	129,604,022	8,540,668	237,205,928	29,537,680	326,269,687	51,311,047	307,592,422	38,336,559	160,487,439	17,036,378
Zinc dross	5,071,067	240,944	8,333,513	506,956	96,575	10,801	26,604,969	2,126,909	31,631,364	2,238,913
Zinc manufactures		210,908		1,951,949		574,229		570,352		722,671
Brass, old, for remanufacturing	20,639,401	2,100,870	11,256,472	1,259,637	6,956,212	1,305,050	8,298,969	1,758,384	4,909,717	799,318
Brass, bars, plates, and sheets	7,115,807	909,153	66,272,144	12,435,782	244,531,706	72,683,626	328,346,666	101,521,426	30,989,717	9,522,934
Brass, articles made from		3,756,888		41,146,025		241,668,081		136,611,299		19,483,146
Cartridges		6,567,122		25,408,079		55,103,904		42,122,656		10,764,765
FOREIGN.										
Zinc, blocks, pigs, and old	11,159,571	218,145	25,550,014	2,355,557	86,459,495	8,080,442	129,360,631	12,429,356	40,138,715	3,532,968
Zinc dust	356,262	17,472	431,815	55,387	390,578	57,695	158,175	21,118	79,512	10,392
Zinc manufactures		18,544		119,104		1,072		50		
Zinc used in articles exported with benefit of drawback	8,256,012	*a* 231,450	63,240	*a* 7,936			3,176,615	*a* 106,478	12,673,361	*a* 364,060
		23,200,628		114,819,368		430,799,939		335,667,630		64,478,045

a Declared value of the zinc used in making the articles exported with benefit of drawback.

Zinc slabs and sheets exported from the United States, 1914–1918, by destination, in short tons.

Destination.	1914		1915		1916		1917		1918	
	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.
Canada	3,383	706	11,138	585	10,216	708	9,427	4,026	6,996	1,052
Great Britain	40,847	2,897	54,526	5,122	60,529	18,847	71,555	24,739	28,334	6,908
Netherlands			12		9			112		
France	8,463	1,902	25,255	6,064	51,810	19,465	41,901	21,596	25,140	10,373
Italy	1,651		8,768	952	14,081	3,933	10,593	9,873	6,130	1,537
Germany	84									
Russia	4,819		12,091		11,786	124	8,238	2,443		
Japan	456		657		882		1,360		5,287	
Other countries	5,099	75	6,156	52	13,822	153	10,722	1,891	8,357	199
	64,802	5,580	118,603	12,775	163,135	43,230	153,796	64,680	80,244	20,069

Zinc slabs and sheets exported from the United States, 1914–1918, by months, in short tons.

Month.	1914		1915		1916		1917		1918	
	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.
January	230	28	15,299	84	10,483	3,531	15,351	2,650	10,435	4,201
February	18		15,002	2,017	10,328	3,919	15,549	4,860	3,226	711
March	146		8,120	1,136	8,171	575	17,408	8,230	7,354	2,036
April	60		8,842	77	9,133	1,902	13,119	3,248	7,509	1,714
May	107	112	7,635	1,104	8,583	4,811	19,528	9,946	4,341	2,979
June	269	27	9,470	1,286	11,309	5,459	12,308	2,246	7,408	417
July	157		6,492	1,876	12,708	4,508	8,863	2,240	5,161	181
August	3,448	319	7,274	421	18,661	4,232	11,307	758	4,055	1,374
September	19,045	1,120	8,653	1,513	19,125	965	8,749	19,624	6,203	1,908
October	10,259	1,140	12,093	608	19,994	6,110	6,057	2,451	8,578	1,464
November	12,747	957	10,019	2,343	18,988	4,260	8,017	1,248	7,478	1,280
December	18,316	1,877	9,704	310	15,652	2,958	17,540	7,179	8,496	1,804
	64,802	5,580	118,603	12,775	163,135	43,230	153,796	64,680	80,244	20,069
Foreign zinc used in articles exported with benefit of drawback		4,128		32				1,588		6,337

The statistics of exports of wire, including barbed and all other wire, as given by the Bureau of Foreign and Domestic Commerce, Department of Commerce, do not distinguish between plain wire and galvanized wire, so that the table below gives no clue to the quantity of galvanized wire exported. The great increase in exports of wire during the war indicates that both the output and exports of galvanized wire must have been greatly increased, as most of the wire used in entanglements, both barbed and plain, was galvanized.

Domestic wire exported from the United States, 1913–1918, in short tons.

	1913	1914	1915	1916	1917	1918
Barbed wire	91,897	105,108	278,454	469,148	216,687	263,293
All other wire	121,222	97,465	251,964	295,839	225,651	176,089
	213,119	202,573	530,418	764,987	442,338	439,382

PRODUCTION AND CONSUMPTION OF ZINC BY SIX-MONTH PERIODS.

In view of the fact that the annual report on zinc is not ready for publication until late in the year it has been customary to include a table showing the production of zinc by smelters in six-month periods, and to include the period following the year to which the annual report refers. Such a table for the period of the war seems properly to belong here in the section dealing with the war activities of the industry.

Zinc produced and consumed in the United States, 1914–1919, by six-month periods, in short tons.[a]

	1914		1915		1916		1917		1918		1919
	First half.	Last half.	First half.	Last half.	First half.	Last half.	First half.	Last half.	First half.	Last half.	First half.
Supply:											
Stock at beginning of period	40,659	64,039	20,095	5,884	14,253	23,879	17,598	33,147	53,721	44,502	41,241
Production—											
From domestic ore	171,496	171,922	207,634	250,501	267,696	296,642	311,539	273,058	242,976	249,429	247,584
From foreign ore	3,562	6,069	8,898	22,486	48,756	55,249	49,599	35,377	14,287	11,235	7,918
Imports (mostly scrap)	506	374	489	415	464	220	136	121	31	4	45
	216,223	242,404	237,116	279,286	331,169	375,990	378,872	341,703	311,015	305,170	296,788
Withdrawn:											
Exports from warehouse	167	5,413	5,704	7,071	20,197	23,033	31,180	33,500	12,058	8,011	9,620
Exports under drawback	1,881	2,247	32	....	....	....	....	1,588	1,851	4,486	3,727
Domestic exports—											
Slabs	830	63,972	64,368	54,235	52,546	98,077	85,578	51,704	34,559	31,809	52,989
Sheets					5,461	7,051	7,685	8,829	5,712	8,164	11,300
Stock at end of period	64,039	20,095	5,884	14,253	23,879	17,598	33,147	53,721	44,502	41,241	59,651
	66,917	91,727	75,988	75,559	102,083	145,759	157,590	149,342	98,682	93,711	137,287
Apparent consumption	149,306	150,677	161,128	203,727	229,086	230,231	221,282	192,361	212,333	211,459	159,501
Zinc smelted in											
Arkansas	....	....	....	....	....	7,503	12,476	13,184	11,773	14,980	14,029
Illinois	62,062	65,884	74,982	84,976	90,082	91,351	95,149	77,340	69,672	72,172	61,701
Kansas	23,737	20,773	35,247	66,176	74,592	66,694	42,359	33,689	12,803	16,346	22,034
Oklahoma	45,443	45,924	51,172	58,036	73,298	94,908	109,130	95,264	69,157	69,909	65,272
Pennsylvania	13,752	14,343	18,828	25,339	34,593	41,952	44,052	42,943	39,133	38,209	37,108
Other States	30,064	31,067	36,303	38,208	42,190	40,064	40,359	38,419	35,273	29,584	32,147
Electrolytic zinc	....	....	....	252	1,697	9,419	17,613	7,596	19,452	19,464	23,211
Total primary zinc	175,058	177,991	216,532	272,987	316,452	351,891	361,138	308,435	257,263	260,664	255,502
Redistilled secondary zinc	10,113	10,432	13,546	16,218	9,924	18,852	12,145	4,690	3,585	6,333	7,328
	185,171	188,423	230,078	289,205	326,376	370,743	373,283	313,125	260,848	266,997	262,830
Yearly total	373,594		519,283		697,119		686,408		527,845		....
Zinc ore imported	9,052	22,910	66,683	92,169	231,845	154,119	142,180	69,415	45,086	25,816	18,570
Zinc content of imported ore	2,949	9,183	23,997	33,672	93,907	54,240	48,958	23,516	15,820	8,989	6,314
Zinc ore exported	8,042	3,068	677	155	33	45	35	1,285	62	....	....
Zinc dross exported	287	2,249	2,932	1,235	28	20	5,236	8,066	7,576	8,240	5,010
Total number of retorts at end of period	....	115,114	130,642	156,568	196,640	219,418	224,778	220,900	176,098	168,544	158,988
Total number of retorts in operation at end of period	....	91,500	129,000	155,000	177,500	204,500	189,500	132,750	107,500	123,500	82,000

[a] Revised from mid-year statement as issued in August, 1919.

CHART OF PRODUCTION AND CONSUMPTION OF ZINC DURING THE WAR.

The chart (fig. 19) shows graphically, for the period of the war, the total supply of zinc (excluding that recovered in pigments smelted directly from ore) and the consumption in this country. The space between the curve marked "production," which shows the output of zinc, and the curve marked *a* shows the stocks at the beginning of the year. The curve *a* therefore represents the total "supply," as the imports of zinc for the period are negligible on the scale of the chart. To get the consumption, the stocks at the end of the year (represented by the space between curves *a* and *b*) must be deducted from the total supply, and therefore the shaded area

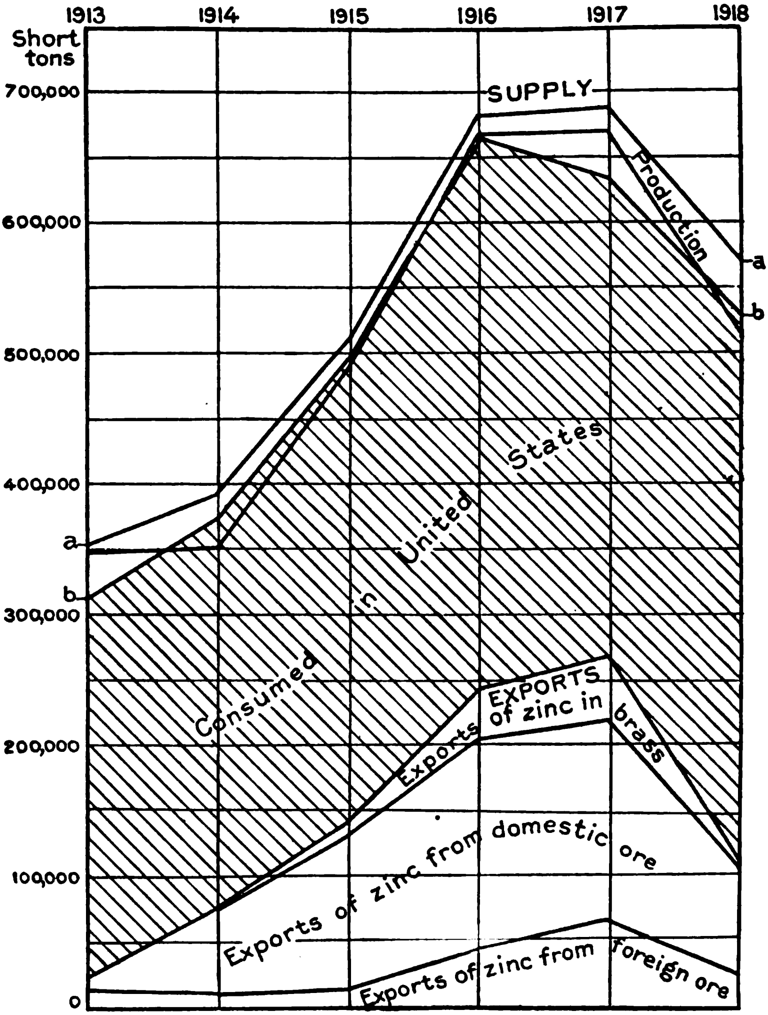

FIGURE 19.—Chart showing production and consumption of zinc during the World War.

representing "consumption" is limited above by the line *b*. The shaded area is limited below by the line showing total "exports," made up of exports of zinc made from domestic and foreign ore as well as of zinc in articles exported with benefit of drawback and exports of zinc in brass, which grew to large proportion in 1916–17. The domestic consumption in 1916 was about one-half greater than in 1913 and 1914, and though it fell off slightly in 1917 it recovered in 1918. Zinc sent abroad for the use of the American Expeditionary Forces is not regarded as exported, and this accounts in part for the expansion in 1918.

GRADES OF ZINC USED DURING THE WAR.

Zinc is classified into grades according to its analysis. The grades generally specified before the war were the "high grade," "intermediate," "brass special," and "prime western" of the American Society for Testing Materials, adopted in 1911. In 1917 the society added another grade, "selected." The War and Navy Departments likewise purchased on closely similar specifications, but the grades were represented by letters, "high grade" being "grade A." As most zinc during the war was brought under these Government specifications the grading by letters largely superseded the older classification for the time being. Since the war the tendency of the trade is to go back to the old familiar grading. The different classifications, with the authorities and dates of adoption, are given in the accompanying table.

Zinc specifications, showing minimum zinc required and maximum impurities permitted, 1911-1918, in per cent.

	Grade A.				Grade B.				Grade C.						Grade D.			
	"High grade," A. S. T. M., 1911.[a]	"High grade No. 1," A. S. T. M., 1918.[b]	Navy, 1917.[c]	Army, 1918.[d]	"Intermediate," A. S. T. M., 1911.[a]	"Intermediate, No. 2," A. S. T. M., 1917.[b]	Navy, 1917.[c]	Army, 1918.[d]	"Brass special No. 3," A. S. T. M., 1917.[b]	"Brass special", A. S. T. M., 1911.[a]	Navy, 1913.[e]	"Selected No. 4," A. S. T. M., 1917.[b]	Navy, 1917.[c]	Army, 1918.[d]	"Prime western," A. S. T. M., 1911.[a]	Navy, 1913.[e]	"Prime western No. 5," A. S. T. M., 1917.[b]	"Prime western," Metal Exchange, 1916.[f]
Zinc, minimum	....	....	99.85	99.50	....	....	99.35	99.35	....	....	98.60	....	98.00	98.00	....	98.00	....	....
Cadmium, maximum	0.05	0.07	.05	.50	0.50	0.50	.50	.50	0.50	0.75	.75	0.75	.75	.75	....	.75	....	....
Iron, maximum	.03	.03	.03	.03	.03	.03	.03	.03	.03	.04	.04	.04	.08	.08	0.08	.08	0.08	0.08
Lead, maximum	.07	.07	.07	.10	.20	.20	.20	.25	.60	.75	.75	.80	1.00	1.00	1.50	1.50	1.60	2.00
Cadmium, iron, and lead, maximum sum	.10	.10	.10	.50	.50	.50	.50	.65	1.00	1.20	1.20	1.25	1.50	1.50	....	2.00	....	....
Aluminum, maximum	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	Tr.	None.	Tr.	Tr.	....	Tr.	....	....
Other elements, maximum	....	....	None.	None.	....	....	Tr.	Tr.	....	....	Tr.	....	Tr.	Tr.	....	Tr.	....	....

[a] Am. Soc. Test. Mat. Proc., vol. 11, pp. 147-149, 1911. Adopted Aug. 21, 1911.
[b] Am. Soc. Test. Mat. Proc., vol. 16, pp. 583-589, 1916; vol. 17, pp. 180-181, 1917.
[c] Navy Department specifications 47Z1d, June 1, 1917.
[d] U. S. Army, Ordnance Department, specifications, revised Mar. 7, 1918.
[e] Navy Department, specifications 47Z1b, Nov. 1, 1913.
[f] New York Metal Exchange, specifications: American Metal Market, Aug. 31, 1916.

TRADE CONDITIONS.

WORLD'S PRODUCTION.

Owing to the disturbed conditions in Europe complete figures of the world's production of zinc are not available.

The following statistics, though incomplete, show approximately the foreign production during the war. The figures in black-faced type are taken from the official statistics of the countries named; those in the ordinary type are taken from statistical handbooks, consular reports, market letters, and trade journals. There is always a possibility of duplication in figures showing European production, for some countries send crude zinc of poor quality to other countries for refining. Furthermore, secondary zinc is included in the figures showing the foreign production, so that to put the United States on an equal footing in the statistics it would be necessary to include in its production the domestic output of secondary zinc.

World's production of zinc, 1913–1918, in metric tons.

[By countries in which smelted; reduced where necessary to metric tons.]

Country.	1913[a]	1913	1914	1915	1916	1917	1918
Australia	3,724	**4,187**	**5,094**	**5,898**	**5,362**	**4,769**	**5,712**
Austria	21,707	19,508	(b)	(b)	(b)	(b)	(b)
Belgium	197,703	**204,220**	**145,925**	**51,660**	**22,980**	**10,290**	**9,245**
Canada				**20**	**2,698**	**9,058**	**11,189**
China	(b)	(b)	(b)	(b)	(b)	(b)	(b)
France	64,103	**67,890**	**42,478**	**19,180**	**20,258**	**22,929**	**18,847**
Germany	283,113	283,113	(b)	(b)	(b)	(b)	(b)
Great Britain	59,146	66,243	50,000	45,000	60,000	50,000	50,000
Holland	24,323	(b)	**16,458**	**11,180**	(b)	(b)	(b)
Italy					**258**	**367**	1,188
Japan		**900**	**5,881**	**21,182**	**88,994**	54,716	44,500
Norway	9,287	9,287	19,000	25,000	32,000	22,000	(b)
Russia	7,610	**10,500**	**6,800**	**2,000**	**1,100**	(b)	(b)
Siberia					**218**	**569**	(b)
Spain	6,920	**6,008**	**11,788**	**8,117**	**8,528**	**10,155**	**15,900**
Sweden		**2,115**	**2,800**	**8,588**	**9,997**	**7,979**	**4,098**
Tasmania						**49**	**8,888**
United States	320,283	**814,498**	**820,279**	**444,082**	**606,807**	**607,423**	**469,858**
	997,919						

[a] Statistics from the Metallgesellschaft for 1913, given for comparison.

[b] Statistics not available.

IMPORTS AND EXPORTS.

The following tables of imports and exports of zinc and of zinc remaining in warehouses are made up from the publications and records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce.

WAREHOUSE TRANSACTIONS.

Zinc imported into the United States as metal or in ore may be entered for immediate consumption, in which case the duty is paid and the zinc goes direct to the importer; or it may be entered for warehouse, bond being given for double the amount of the estimated duty. In accordance with the usage of the Bureau of Foreign Commerce, the term "General imports" in the accompanying tables indicates the total zinc imports, including both zinc articles entered for immediate consumption on arrival and zinc articles entered for warehouse, as distinguished from "Imports for consumption," embracing zinc imports entered for immediate consumption and zinc withdrawals from warehouse for consumption. The statement of general imports and the statement of imports for consumption for any period will differ to the extent that the entries for warehouse for the period differ from withdrawals from warehouse for consumption.

From warehouse the zinc ore may be withdrawn for consumption by payment of duty, or it may be exported from warehouse as ore, or it may be smelted in bond, the metal finally being either withdrawn for consumption or exported from warehouse with cancellation of bond. In the tables of imports for consumption the imports are expressed in the terms under which they were originally entered. The zinc imported for consumption may be actually used in the country or it may be manufactured and exported, in which case the manufacturer is entitled to the benefit of a drawback of 99 per cent of the duties paid. In the table showing foreign zinc exported in manufactures with benefit of drawback the zinc is shown in the form in which it was originally imported, because, on account of diversity of manufactured form, it is not feasible to show the articles actually exported. The foreign zinc given in the table below as exported from warehouse is likewise shown in the form in which it was imported and entered for warehouse. Foreign zinc exported from warehouse has, since July 1, 1915, been included by the Bureau of Foreign and Domestic Commerce in the domestic exports as "from foreign ore."

The items foreign zinc exported from warehouse, domestic exports of zinc "from foreign ore," and foreign zinc exported in manufactures with benefit of drawback make up the total foreign zinc going out of the country. For the sake of simplicity this foreign zinc is carried on the records of the bonded customs warehouse in the form in which the zinc was entered until the bond is canceled. It must be clearly understood, therefore, that the zinc listed in the table of foreign exports of zinc, on a later page, was not exported as zinc content of ore but as metal smelted from the ore. This has been shown in the Monthly Summary of the Bureau of Foreign and Domestic Commerce since July, 1915, as noted above.

No record is kept of the zinc in the form in which it is actually exported, except for that portion of the articles manufactured from foreign zinc and exported with benefit of drawback. For articles not wholly made of zinc it would be useless to give weights, but each shipment on which drawback is claimed is accompanied by a manifest of the imported zinc used in making the articles and the duty paid thereon. From these manifests is derived the statement of the total quantity of foreign zinc used in manufactures exported with the benefit of drawback. For this reason the zinc is given in the form in which it was imported.

ZINC REMAINING IN WAREHOUSE.

The following table is taken from the reports of the Bureau of Foreign and Domestic Commerce. For the reasons already given the zinc is shown in the terms in which it was imported. For instance, a considerable part of the zinc stated as remaining in ore doubtless represents metal waiting at the bonded zinc smelter for a favorable market for shipment. If this is borne in mind the table gives an idea of the fluctuation of stocks of foreign zinc.

The quantity of zinc remaining in warehouse at the end of each year prior to 1909 has been negligible, but since all zinc ore became dutiable, on August 6, 1909, the quantity of bonded zinc has largely increased. The large imports of foreign zinc ore on account of the demand for munitions greatly swelled the quantity remaining in warehouse December 31, 1915 and 1916, as will be seen in the accompanying tables.

Practically all the zinc in ore remaining in warehouse prior to 1915 was credited to the port of Kansas City, Mo., and was in possession of the bonded zinc smelters of Kansas and Oklahoma. In 1915–1917 eastern zinc smelters were large consumers of foreign ores, and at the end of these years considerable ore remained in warehouse in that section.

Zinc remaining in warehouse in the United States Dec. 31, 1909–1918.

Year.	Ore and calamine.			Blocks, pigs, and old.		Zinc dust.	
	Quantity (short tons).	Zinc content (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1909	2,813	2,255,341	$36,384	78,667	$4,021	(a)	(a)
1910	2,603	2,572,122	61,730	61,146	3,406	(a)	(a)
1911	10,177	6,978,098	137,055	63,454	4,049	(a)	(a)
1912	3,076	2,479,565	62,089	....	....	310,715	$18,072
1913	7,531	1,930,425	68,726	....	....	291,612	16,008
1914	6,728	6,987,676	90,257	221,994	11,100	272,915	13,005
1915	63,168	43,691,611	1,628,509	63,892	4,028	115,375	8,815
1916	82,227	57,259,940	2,210,286	180,026	14,301	120,921	12,989
1917	96,560	53,997,636	1,177,680	63,545	3,949	64,812	5,710
1918	(b)	53,766,247	1,089,560	....	....	....	....

(a) Not separately recorded prior to 1912.

(b) Figures not available.

The figures for 1910–1912 are exclusive of the zinc contained in certain other ores entered at New York, as explained later in the discussion of the table of general imports of zinc.

IMPORTS.

Zinc imported and entered for consumption in the United States, 1910–1918.

Year.	Blocks or pigs.		Sheets.		Old.		Value of manufactures.	Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.		
1910	989	$95,410	262	$36,641	257	$17,549	$1,526	$151,126
1911	323	38,322	296	55,211	104	8,609	7,981	110,123
1912	10,719	1,239,574	728	102,073	147	13,748	8,489	1,363,884
1913	5,165	565,215	223	43,497	275	17,850	5,474	632,036
1914	195	21,140	277	32,004	388	26,512	4,464	84,120
1915	63	16,864	95	14,407	729	103,294	622	135,187
1916	21	4,436	2	432	642	112,254	829	117,951
1917	18	2,279	73	16,570	259	25,974	250	45,073
1918	11	2,897	....	29	24	2,056	331	5,313

Zinc dust, zinc oxide, and lithopone, imported and entered for consumption in the United States, 1910–1918.

Year.	Zinc dust.		Zinc oxide.				Lithopone.[a]	
			Dry.		In oil.			
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1910	1,493	$136,749	3,069	$365,701	197	$30,874	1,863	$99,954
1911	1,713	177,420	2,506	316,972	274	40,494	3,178	166,199
1912	2,736	306,061	2,675	342,985	262	43,168	2,952	153,303
1913	2,368	248,482	3,291	410,493	142	23,663	2,533	152,980
1914	2,004	191,582	2,461	279,642	168	23,196	4,036	277,822
1915	707	137,474	853	148,220	29	5,929	2,126	144,567
1916	522	230,380	447	181,319	18	4,076	2,372	414,592
1917	233	48,604	119	52,649	5	876	229	35,718
1918	16	3,552	162	62,703	4	1,043	1	993

[a] This heading includes imports of lithopone and "zinc sulphide white." The imports for 1918 consisted of 2,670 pounds of "zinc sulphide white" and no lithopone—hence the high value.

General imports of old brass fit only for remanufacture, 1903–1918.

[Average composition about one-third zinc and two-thirds copper.]

Year.	Quantity (short tons).	Value.	Year.	Quantity (short) tons).	Value.
1903	608	$154,260	1910	3,072	$786,684
1904	1,330	310,311	1911	1,803	445,116
1905	4,838	1,169,320	1912	3,298	639,045
1906	6,469	1,891,126	1913	4,363	907,521
1907	3,979	1,344,753	1914	2,565	487,542
1908	1,357	355,335	1915	8,354	1,809,550
1909	2,336	579,454	1916	22,976	6,578,809
			1917	28,035	9,949,524
			1918	6,114	1,773,789

Two tables which show the importation of zinc ores are given below. The first one shows the zinc ores imported and entered for consumption under the tariff act of 1909, when different grades of ore bore different duties, and also shows the imports under the tariff act of 1913, which levies an ad valorem duty, thus making one class of all grades of zinc ore. The other table shows the general imports of zinc by countries. The difference between general imports and imports for consumption has been explained on pages 1061–1062.

Zinc ore and calamine imported and entered for consumption, 1910–1918.

Year.	Containing less than 10 per cent of zinc (duty free).		Containing from 10 to 20 per cent of zinc (duty, ¼ cent per pound).		Containing from 20 to 25 per cent of zinc (duty, ½ cent per pound).		Containing 25 per cent or more of zinc (duty, 1 cent per pound).	
	Zinc content (short tons).	Value.	Zinc content (short tons).	Value.	Zinc content (short tons).	Value.	Zinc content (short tons).	Value.
1910	16	$698	87	$4,053	1,178	$25,127	19,961	$713,684
1911	39	1,411	189	8,705	564	16,914	3,349	120,756
1912	22	1,141	56	3,045	458	6,734	10,328	433,570
1913	....	....	[a] 45	[a] 2,067	[b] 309	[b] 4,305	[c] 4,093	[c] 193,014
1914	....	....	....	....	....	....	5,548	149,503
1915	....	....	....	....	....	....	16,282	1,312,833
1916	....	....	....	....	....	....	55,796	3,836,414
1917	....	....	....	....	....	....	33,517	1,123,534
1918	....	....	....	....	....	....	8,501	291,449

[a] For period July 1-Dec. 31 only.

[b] For period Jan. 1-Oct. 3, 1913.

[c] Includes all classes after Oct. 4, 1913.

The statistics of general imports as published by the Bureau of Foreign and Domestic Commerce are based on "consular invoice" or "declaration," which is only a close approximation to actual weights and values. The true weights and values of all dutiable articles are determined when the duties are paid, and the correction is applied as "additions by liquidation" or "deductions by liquidation." On free articles this correction is not made. Prior to 1909 zinc ore was in large part undutiable, and in that part of 1909 prior to August 6 a portion of the imports of zinc ore was free. The correction by liquidation for the dutiable zinc ore imported during 1909–1912 is available, but, owing to special instructions followed in one customs district, to apply the correction by liquidation would result in a considerable duplication of imports. The following figures are taken directly from the Monthly Summary of the Bureau of Foreign and Domestic Commerce without the liquidation correction:

General imports of zinc ore into the United States, 1904–1918.

Year.	1904–1914.							
	Canada.		Mexico.		Other countries.		Total.	
	Ore (short tons).	Zinc content (short tons).	Ore (short tons).	Zinc content (short tons).	Ore (short tons).	Zinc content (short tons).	Ore (short tons).	Zinc content (short tons).
1904	....	....	2,264	....	....	....	2,264	....
1905	4,063	....	18,074	....	....	....	22,137	....
1906	423	....	54,991	....	....	....	55,414	....
1907	1,112	....	102,005	....	....	....	103,117	....
1908	7,406	....	46,351	....	....	....	53,757	....
1909	10,024	....	104,826	....	....	....	114,850	....
1910	4,749	1,922	67,877	23,517	....	....	72,626	25,439
1911	2,359	947	36,757	14,986	....	....	39,116	15,933
1912	8,015	3,661	35,925	13,606	....	....	43,940	17,267
1913	8,899	3,498	17,476	6,160	5,041	3,839	31,416	13,497
1914	11,250	4,467	20,705	7,663	7	2	31,962	12,132

General imports of zinc ore into the United States, 1904–1918—Continued.

Country.	1915			1916		
	Ore (short tons).	Zinc content (short tons).	Value.	Ore (short tons).	Zinc content (short tons).	Value.
Canada	11,992	4,710	$177,868	21,908	8,790	$567,259
Mexico	57,699	17,804	2,130,014	161,271	51,028	5,779,564
France				3,884	1,422	56,542
Spain				55,965	23,081	1,550,334
Italy	5,312	2,125	153,388	12,550	5,783	394,782
French Africa				4,480	1,857	129,153
French East Indies				1,653	746	55,407
China and Hongkong	5,880	2,738	119,913	9,641	4,568	344,192
Japan	1,369	499	77,899			
Australia	76,410	29,724	1,843,801	113,862	50,601	3,223,184
Other countries	190	69	7,663	750	271	20,968
	158,852	57,669	4,510,546	385,964	148,147	12,121,385

Country.	1917			1918		
Canada	16,559	5,155	$338,668	14,987	5,173	$319,815
Mexico	145,358	45,697	2,837,211	53,348	18,426	1,202,035
Spain	14,778	6,083	260,922			
Italy	5,919	2,411	117,271			
French Africa	1,245	623	66,346			
Australia	27,730	12,503	753,598			
Other countries	6	2	42	2,567	1,210	52,119
	211,595	72,474	4,374,058	70,902	24,809	1,573,969

The foregoing figures showing imports of zinc ore in 1910 do not include 10,431 short tons of other ore that carried 2,645,111 pounds of zinc as an accessory constituent, an average of less than 13 per cent, which was lost in smelting the ore, and hence for the purpose of this report such ore can not be classed with imports of zinc ore so long as the present metallurgic treatment of such zinc-bearing ores prevails. Similarly, the figures for 1911 are exclusive of 25,769 tons of other ore, carrying 6,283,437 pounds of zinc, and those for 1912 are exclusive of 18,245 tons of other ore, carrying 4,862,508 pounds of zinc. The duties on the zinc contents of this ore have since been refunded and the bonds canceled. The ore was shipped from South American ports and largely entered through the port of New York. It is shown in the Monthly Summary of the Bureau of Foreign and Domestic Commerce under the heading of "Merchandise remaining in warehouse," mostly at New York. Such ores have entered free and have not been enumerated since 1912.

EXPORTS.

DOMESTIC EXPORTS.

The practice of the Bureau of Foreign and Domestic Commerce is to class all exports of zinc articles made in this country as domestic exports, whether the zinc is of domestic or foreign origin. Hence, the following table of domestic exports is duplicated in part in a later table of foreign zinc in manufactures exported with benefit of drawback. The exports of zinc ore in the table below are of domestic origin and in recent years have all gone from one mine in New Jersey. The exports of plates, sheets, pigs, or slabs are likewise probably wholly domestic, because, as shown later, all the zinc in manufactures going out under drawback came in as blocks, pigs, and sheets, and the only manufacturing process which would put any of these into the class of exports referred to is rolling into sheets. But the zinc rolling mills in this country do not use foreign metal, hence the conclusion that the plates, sheets, pigs, and slabs of the table are of domestic origin. The exports of zinc dross are, no doubt, in part of foreign origin, but in what proportion can not be determined. However, they are not duplicated in the drawback table. The exports of manufactures, of which the value is given, include the whole of the manufactures exported with benefit of drawback, as well as whatever manufactures of domestic zinc may be exported.

Domestic zinc ore and domestic manufactures of zinc exported from the United States, 1909–1918.

Year.	Zinc ore.		Plates, sheets, pigs, or slabs.		Zinc dross.		All other manufactures.[a]	Total Value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Value.	
1909	[b] 12,455	$412,300	2,566	$263,010	7,069	$477,112	$69,751	$1,222,173
1910	[b] 19,711	649,425	3,990	426,560	4,729	380,950	101,336	1,558,271
1911	[b] 18,281	642,884	6,872	810,099	4,246	348,176	134,518	1,935,677
1912	[b] 23,349	823,997	6,634	864,292	205	17,985	140,027	1,846,301
1913	[b] 17,713	631,991	7,783	955,667	28	1,457	145,984	1,735,099
1914	[b] 11,110	388,464	64,802	8,540,668	2,536	240,944	210,908	9,380,984
1915	[b] 832	35,276	118,603	29,537,680	4,167	506,956	1,951,949	32,031,861
1916	78	3,992	163,135	51,311,047	48	10,801	574,229	51,900,069
1917	1,320	63,043	[c] 153,796	38,336,559	13,302	2,126,909	570,352	41,096,863
1918	62	2,480	[c] 80,244	17,036,378	15,816	2,238,913	722,671	20,000,442

[a] Not including brass.

[b] The exports consisted wholly of high-grade willemite ore from New Jersey.

[c] The quantity and value of domestic zinc exported as sheets and strips are given on page 1031.

Zinc oxide exported from the United States, 1902–1918.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1902	5,358	$433,722	1911	14,618	$1,051,311
1903	7,215	578,215	1912	17,064	1,247,702
1904	8,157	628,494	1913	14,467	1,136,257
1905	11,280	810,203	1914	15,592	1,408,525
1906	15,578	1,149,297	1915	19,989	2,068,428
1907	13,257	1,069,924	1916	13,942	2,394,709
1908	12,008	845,070	1917	15,446	3,148,898
1909	14,846	1,026,377	1918	12,421	2,779,507
1910	13,167	943,938			

Domestic brass and brass manufactures exported from the United States, 1911–1918.

[Zinc content approximately 30 per cent by weight.]

Year.	Bars, plates, and sheets.		Scrap and old.		Articles made from (value).	Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.		
1911	1,152	$314,089	9,409	$1,703,131	$5,352,868	$7,370,068
1912	3,431	1,058,560	14,435	3,090,833	5,036,197	9,185,590
1913	3,056	933,949	10,943	2,292,349	4,719,119	7,945,417
1914	3,558	909,153	10,320	2,100,870	3,756,888	6,766,911
1915	33,136	12,435,782	5,628	1,259,637	41,146,025	54,841,444
1916	122,266	72,683,626	3,478	1,305,050	241,668,081	315,656,757
1917	164,173	101,521,426	4,149	1,758,384	136,611,299	239,891,109
1918	15,495	9,522,934	2,455	799,318	19,483,146	29,805,398

This table does not include all the brass exported in munitions. For instance, the large exports of shrapnel are included by the Bureau of Foreign and Domestic Commerce under "All other explosives," which increased in value from $651,601 in 1913 to $95,129,957 in 1915, and $394,136,334 in 1916, but fell to $202,252,574 in 1917, and $41,406,865 in 1918. Munitions sent overseas to the American Expeditionary Forces are not counted as exports.

FOREIGN EXPORTS.

"Foreign zinc exports" are the exports of zinc of foreign origin which has been smelted or manufactured in this country and then shipped abroad. The following table, made up from the records of the Bureau of Foreign and Domestic Commerce, shows the total zinc exported from warehouse during the last 14 years—the exports prior to that period being of insignificant proportions—and also the foreign zinc exported in manufactures with benefit of drawback for the same period. These two items—foreign zinc exported from warehouse and foreign zinc in manufactures exported with benefit of drawback—make up the total foreign zinc going out of the country. Zinc in warehouse and deductions by liquidation being disregarded, the difference between the sum of these two exports of zinc and the total imports of zinc constitutes the foreign zinc consumed in this country. The zinc recorded in this table was not exported as zinc content of ore and blocks, pigs, etc., but as zinc smelted or manufactured from them. The reason for this method of reporting is that the zinc in bonded customs warehouse is carried on the records until the bond is canceled in the same form in which the zinc was entered for warehouse. The zinc content of the foreign ore is, of course, exported as metallic zinc and manufactures of zinc. In the Monthly Summary of the Bureau of Foreign and Domestic Commerce since July 1, 1915, the exports of foreign zinc have been wholly classed as metallic zinc; that is, as "exports of domestic spelter, cast in pigs, slabs, etc.," either "produced from domestic ore" or "produced from foreign ore."

Under present customs regulations zinc equivalent in quantity to the total recoverable zinc content must be exported to procure cancellation of bond. The quantities as given for zinc exported from warehouse are exact, but the quantities as given for zinc exported in manufactures under drawback are subject to wastage in manufacturing.

Except for a portion of the articles manufactured from foreign zinc and exported with benefit of drawback, no record is kept of the form in which the zinc is actually exported. Unless the zinc is the constituent of chief value, the actual quantity of zinc is not recorded. But each shipment on which drawback is claimed is accompanied by a manifest of the imported zinc which was used in making the articles, as well as the duty paid thereon. From these manifests is made up the statement of the total quantity of foreign zinc which went into manufactures exported with benefit of drawback, and for this reason the zinc is given in the form in which it was imported.

Foreign zinc exported from the United States in 1905–1918.

Year.	Exported from warehouse.					Exported in manufactures with benefit of drawback, slabs and sheets excluded (short tons).
	Ore and calamine, zinc content.		Blocks, pigs, and old.		All other manufactures (value).	
	Quantity (short tons).	Value.	Quantity (short tons).	Value		
1905			19	$816	$1,015	
1906			1	252	1,962	2
1907			9	1,023	1,504	1,555
1908			8	964	4,635	1,234
1909	[a] 328	[a] $6,429	6	752	521	
1910	4,710	182,345	47	4,884	1,121	4,486
1911	10,818	476,233	458	21,141	2,701	3,079
1912	6,778	306,726	48	4,346	30,619	1,219
1913	5,406	214,437	620	66,919	6,231	7,459
1914	140	5,909	5,580	218,145	18,544	4,128
1915			12,775	2,355,557	119,104	32
1916			43,230	8,080,442	1,072	
1917			64,680	12,429,356	50	1,588
1918			20,069	3,532,968		6,337

[a] After Aug. 6, 1909.

CONSUMPTION.

APPARENT CONSUMPTION OF PRIMARY ZINC.

The rapidly increasing quantity of secondary material, such as zinc skimmings, ashes, hard zinc, and scrap zinc, from which zinc is recovered in the form of metal, alloy, pigment, or chemical, and so used again, affects the consumption of primary zinc. The total quantity of secondary zinc recovered in 1918, so far as there is available record, was 120,590 tons, as compared with 116,200 tons in 1917. For details of the recovery of secondary zinc in 1918 and previous years, see pages 593 and 596–597.

In the following table only zinc made from ore—that is, primary zinc, is taken into account.

Primary zinc consumed in the United States, 1913–1918, in short tons.

	1910–1913 (average).	1914	1915	1916	1917	1918
Supply:						
Stock Jan. 1:						
In bonded warehouses	38	....	111	32	90	32
At smelters	11,973	40,659	19,984	14,221	17,508	53,689
Production	310,298	353,049	489,519	668,343	669,573	517,927
Imports	4,946	880	904	684	257	35
Total available	327,255	394,588	510,518	683,280	687,428	571,683
Withdrawn:						
Exports, foreign, from warehouse	7,087	5,580	12,775	43,230	64,680	20,069
Exports, foreign, under drawback	4,061	4,128	32	....	1,588	6,337
Exports, domestic	6,320	64,802	118,603	163,135	153,796	80,244
Stock Dec. 31:						
In bonded warehouses	28	111	32	90	32	....
At smelters	19,346	19,984	14,221	17,508	53,689	41,241
Total withdrawn	36,842	94,605	145,663	223,963	273,785	147,891
Apparent consumption	290,413	299,983	364,855	459,317	413,643	423,792

The domestic consumption of zinc of foreign origin, both that made in this country from foreign ore and that imported directly as metal, is a matter of much importance to American zinc producers and smelters. A certain portion of the stocks reported by the smelters as on hand at the end of the year must consist of zinc made from foreign ores, and this has not been taken into consideration in the following table; but, although this omission affects the statistics of consumption for any single year, it does not impair the usefulness of a table covering the length of time here given.

Foreign zinc consumed in the United States, 1913–1918, in short tons.

	1910–1913 (average).	1914	1915	1916	1917	1918
Supply:						
Stocks in warehouse Jan. 1	38	....	111	32	90	32
Production from foreign ore	13,983	9,631	31,384	104,005	84,976	25,522
Imports	4,946	880	904	684	257	35
Total supply	18,967	10,511	32,399	104,721	85,323	25,589
Withdrawn:						
Exports from warehouse	7,087	5,580	12,775	43,230	64,680	20,069
Exports under drawback	4,061	4,128	32	....	1,588	6,337
Stocks in warehouse Dec. 31	28	111	32	90	32	....
Total withdrawn	11,176	9,819	12,839	43,320	66,300	26,406
Consumption of foreign zinc	7,791	692	19,560	61,401	19,023	−817

CONSUMPTION BY USES.

Zinc has been used in the United States chiefly for galvanizing. For many years statistics of the consumption of zinc for different purposes were published by the Engineering and Mining Journal. The figures for 1909, the last published before the war, gave 62.7 per cent of the output of zinc as used in galvanizing, 18.3 per cent as used in making brass, 12.6 per cent as rolled into sheet zinc, 1 per cent for the desilverization of lead, and 5.4 per cent for all other purposes.

These figures are fairly typical of the prewar period. During the war the percentage of the total output used in galvanizing must have been less than 60 per cent, for the output of zinc was much greater, and there was an actual decrease in certain lines of galvanizing, as is shown in a later table. The quantity of zinc used in making brass was very much larger than ever, and it seems reasonable to assume that the percentage of the total output so used was also greater than in 1909. Likewise, the quantity though perhaps not the percentage of zinc used in making sheet zinc was larger. In view of the interest in these changes during the war period, W. R. Ingalls[3] canvassed the consumption of zinc by uses for 1916 and 1917 with the results shown in the following table:

Zinc consumed in the United States, 1909, 1916–1918, by uses.

Use.	1909		1916		1917		1918
	Quantity (short tons).	Percentage.	Quantity (short tons).	Percentage.	Quantity (short tons).	Percentage.	Quantity (short tons).
Galvanizing	164,000	62.7	200,000	44.4	190,000	42.7	[a] 175,000
Brass-making	48,000	18.3	175,000	38.9	170,000	38.2	([b])
Sheet zinc	33,000	12.6	47,500	10.5	57,000	12.8	[c] 69,887
Lead desilverization	2,600	1.0	6,100	1.4	6,300	1.4	([b])
Castings	14,000	5.4	2,300	4.8	2,300	4.9	([b])
Other purposes			4,300		4,300		
Unclassified			15,100		15,000		
	261,600	100.0	450,000	100.0	445,000	100.0	....

[a] Estimated as described on p. 1072. [b] Data not available. [c] Total rolled zinc as given on p. 1031.

The annual statistical reports of the American Iron and Steel Institute give the statistics of output of various forms of galvanized iron and steel articles by the members of the institute. Not all forms of galvanized products are included, and of course the output of nonmembers is lacking. Nevertheless the figures give a measure of comparison of the galvanizing industry from year to year. The quantity of zinc used is not given, but it is possible to arrive at fairly close estimates of the percentage by weight of zinc used in the different classes of galvanized articles. Such articles designed for export are usually coated with foreign zinc so that a drawback of the duty paid may be claimed. The reports of the Bureau of Foreign and Domestic Commerce, Department of Commerce, show that from July 1, 1912, to December 31, 1918, 223,741,291 pounds of zinc-coated iron and steel sheets and plates were exported for which a drawback of 27,770,020 pounds of foreign zinc used, or 12.4 per cent by weight, was claimed. Also 455,376,748 pounds of galvanized barbed and other wire was exported, on which drawback for 12,624,805 pounds of zinc, or 2.8 per cent by weight, was claimed. From a number of producers of galvanized articles the following details of consumption of zinc were obtained: In 43,088 tons of zinc-coated sheets was used 4,551 tons of zinc, or 10.6 per cent by weight, and in 19,670 short tons of galvanized wire was used 5,762 tons of zinc, or 2.9 per cent by weight. There is a fair agreement between these sets of figures. The percentage of consumption of zinc in galvanized wire should be fairly constant, but the quantity used in coated sheets and articles will be about the same regardless of the weight of the sheet or the article, and thus the weight percentage of the zinc will vary. The large quantities given above must have included an average representation of weights and gages, however, and so 12 per cent may be taken as the average percentage by weight of zinc used in zinc-coated sheets, and it is assumed that the percentage of zinc used in galvanized tubes and formed products is the same. The percentage of zinc used in zinc-coated sheets has been applied to the yearly total weight of galvanized sheets, tubes, and formed products as given by the Iron and Steel Institute, and the estimated quantities of zinc consumed are set beneath these totals in the table below, which does not include galvanized wire and galvanized cast or wrought iron and steel articles.

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[3] Ingalls, W. R., Spelter statistics for 1917: Eng. and Min. Jour., vol. 106, pp. 176-181, 1918.

Galvanized iron and steel sheets, formed products, and tubes produced in the United States, 1913–1918, in short tons, with an estimate of the quantity of zinc used in galvanizing them.

	1913	1914	1915	1916	1917	1918
Galvanized iron and steel sheets [a]	922,932	903,834	790,785	673,462	636,989	579,889
Galvanized formed products [a] [b]	64,595	65,802	56,096	65,151	57,451	60,555
Galvanized tubes [a]	298,973	296,832	314,657	325,935	308,342	296,444
	1,286,500	1,266,468	1,161,538	1,064,548	1,002,782	936,888
Zinc used (estimated)	154,380	151,976	139,385	127,746	120,334	112,427

[a] From annual statistical reports of American Iron and Steel Institute.
[b] Articles formed or stamped from iron or steel sheets and galvanized after shaping.

The quantities of zinc estimated above as used in galvanizing in 1916 and 1917 by members reporting to the American Iron and Steel Institute average about 63.6 per cent of the total quantities estimated as used for galvanizing by Ingalls. If we assume the same ratio held in 1918, we may estimate the total zinc used in galvanizing in 1918 as about 175,000 tons, as given in the table on page 1071.

PRICES AND VALUE.

PRICES.

The price quoted for prime western zinc for immediate delivery at St. Louis was 7.7 cents a pound at the beginning of 1918, having declined to that point from 10.75 cents in the first quarter of 1917. There was a slight recovery from this downward trend in January of 1918, but it was soon resumed and brought the price down to 6.65 cents near the end of May. From this point the trend in price was upward, except in July, and it reached 9.5 cents in September. A decline brought the price down to 7.7 cents at the end of the year. The average quoted price for the year for prime western zinc at St. Louis was 8 cents. On February 13, 1918, the War Industries Board fixed on grade A zinc a maximum price of 12 cents a pound f. o. b. cars at East St. Louis. By extensions, this price held until the end of the year.

Experience has shown that large sales of zinc for future delivery at considerable variations in price, as well as the sales of metal of better grades than prime western at much higher prices than that grade, render the average price quoted for prime western zinc an unsafe guide to the average value of all zinc sold. A canvass of the actual sales of zinc and the prices received in 1918 gives 9.1 cents a pound as the average selling price of all grades—A, B, C, and prime western—which may be compared to 8 cents, the average quoted price at St. Louis for prime western metal. The average selling price for all grades is the price used in calculating the value of the zinc output of the country. The table below gives the average selling price of each grade of zinc in 1917 and 1918, and the average selling price of all grades since 1915, as calculated from the total receipts from sales by producers; in addition the price of high-grade metal is given for earlier years.

Prices of zinc, by grades, 1913–1918.

[In cents per pound; average price received except as otherwise stated.]

	1913	1914	1915	1916	1917	1918
Grade A (high grade of 1913–1916)	[a] 8.5	[a] 8.0	[a] 31.1	[a] 23.2	14.0	11.1
Grade B (intermediate of 1913–1916)					12.7	10.7
Grade C (select and brass special of 1913–1916)					9.4	8.0
Grade D (prime western)					9.0	7.9
All grades			12.4	13.4	10.2	9.1
Prime western, average spot quotation at St. Louis	5.6	5.1	14.2	13.6	8.9	8.0

[a] Am. Zinc Inst. Bull., vol. 3, No. 3, p. 7, 1920; averaged from monthly prices.

The London daily price quotation for zinc in 1918 for prompt delivery under Government control remained unchanged at £54 a long ton (nearly 11.5 cents a pound) until November 26, when it was raised to £56 a long ton (11.9 cents a pound). The zinc market reopened on December 18.

At the beginning of 1918 the base price of sheet zinc was 19 cents a pound. On February 13 the War Industries Board fixed until June 1, 1918, a maximum base price of 15 cents a pound for zinc sheets and 14 cents a pound for zinc rolled plates f. o. b. plant, subject to the usual trade discounts and differentials. These prices were twice extended and expired by limitation on January 1, 1919. As explained on a preceding page 1051, at the instance of the War Industries Board, an arrangement between the sheet-zinc rollers and the Joplin ore producers was agreed to through which a price of $75 a ton was paid for low-lead Joplin concentrates. Prices for 1914 to 1917, inclusive, are given on page 1032. The average price obtained for all rolled zinc sold during the year was 15 cents, as compared with 17.5 cents in 1917.

Zinc dust at the beginning of 1918 was quoted at 16 to 17 cents a pound, the price depending on quality. The price soon dropped to 14 to 16 cents and remained at that point practically through the year, except for some oscillations in July and August. At the end of the year the quotation was 13 to 15 cents a pound. The average of quotations for the year was 14.5 cents. The average price received during the year as reported by the producers is shown on page 1033 and was 10.9 cents for prepared "blue powder" and 13 cents for "atomized" zinc dust. It is probable that the difference in price between "blue powder" and "atomized" zinc dust is somewhat greater than that indicated in the table on page 1033.

PRICE CURVES, 1914-1919.

Plate IX shows graphically for the years 1914–1919 the relations of the weekly average St. Louis quoted price of zinc, the weekly average London price of zinc, the weekly average price of 60 per cent zinc blende concentrates at Joplin, Mo., and the weekly sales of concentrates in the Joplin region as a whole. The price of zinc has been taken from market reports, and the price of zinc blende and the figures of weekly sales are those published in the Joplin daily papers. To eliminate the sharp weekly fluctuations and to obtain a curve more easily comparable with the price curves, the weekly sales have been averaged by months, the result being shown by the broken lines.

The figures given in preceding pages and the price curve on the accompanying diagram show that in 1914, the year the war began, zinc reached in October the lowest price for the period covered—4.6 cents a pound. In the next year, 1915, zinc reached in June the highest price attained during the war, prime western metal selling for 26.5 cents a pound and high-grade zinc selling for 40 cents a pound. The break in prices in the summer of 1915 was followed by high prices early in 1916. By this time the output made in consequence of the greatly increased smelter capacity had more than supplied the war need for zinc, and prices dropped rapidly to the lower level at which they have since remained.

The curve of the London price of zinc for the first seven months of 1914 shows that zinc was about two-fifths of a cent higher in St. Louis than in London. Through this period the price was about at a level. With the outbreak of the war London became the center of the demand for zinc for munitions and the London price became higher than the St. Louis price except for short intervals. In April, 1917, the London price was fixed by the British Government, and thereafter until practically the end of 1918 the curve is a straight line showing a "spread" between London and St. Louis prices ranging from 2 to 4.5 cents a pound.

VALUE.

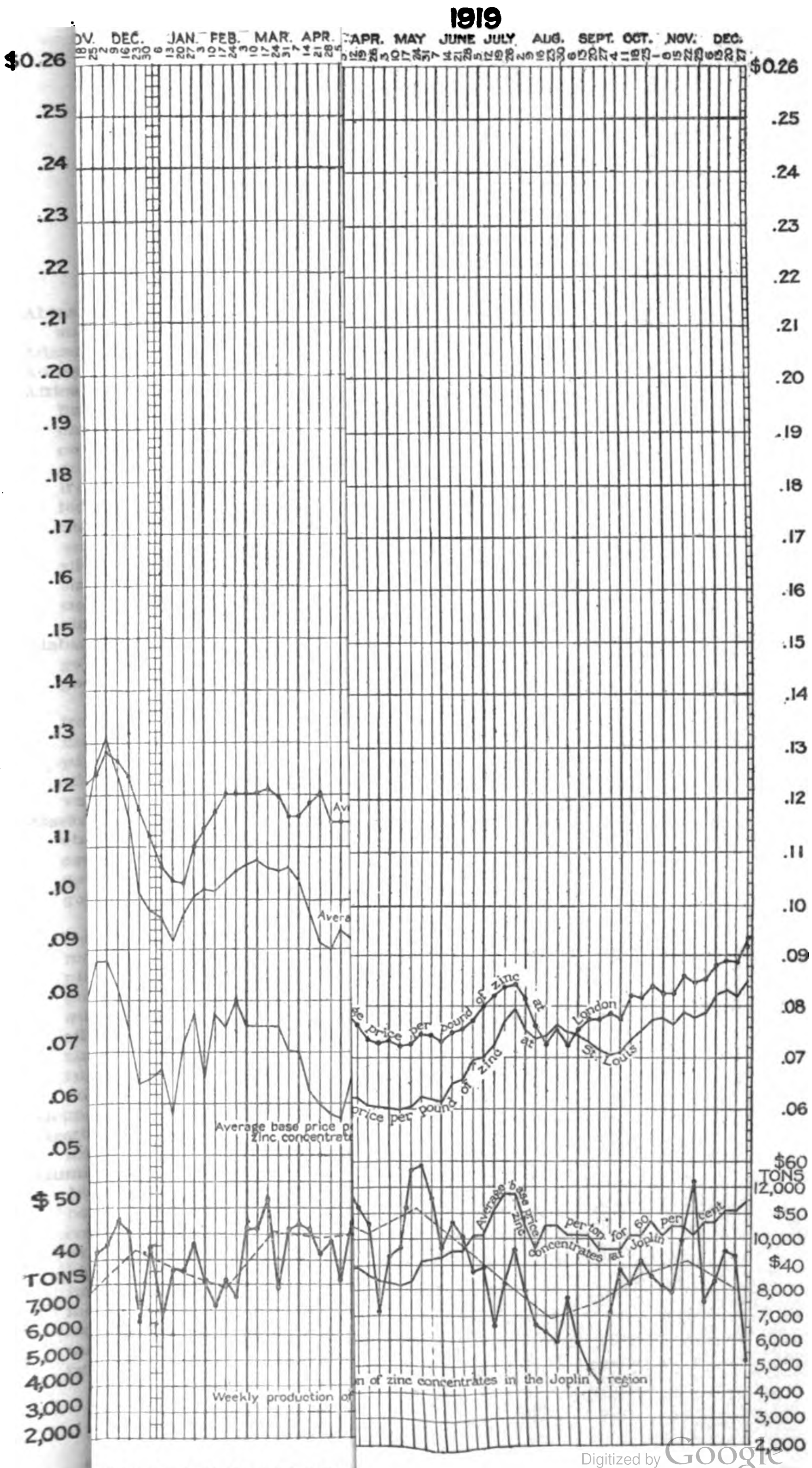
The output of primary zinc from domestic ores in 1918 was 492,405 short tons, valued at $89,618,000, based on the average selling price—a decrease of 92,192 tons, or about 16 per cent, in quantity and of $29,640,000, or about 25 per cent, in value, as compared with 1917.

Distilled and electrolytic zinc produced in the United States, 1910–1918.

Year.	Domestic primary.		Foreign primary.		Redistilled secondary.		Total.	
	Quantity (short tons).	Value. [a]	Quantity (short tons).	Value. [a]	Quantity (short tons).	Value. [a]	Quantity (short tons).	Value. [a]
1910–1913 [b]	296,315	$35,176,000	13,983	$1,654,000	19,720	$2,372,000	330,018	$39,202,000
1914	343,418	35,029,000	9,631	982,000	20,545	2,096,000	373,594	38,107,000
1915	458,135	113,617,000	31,384	7,783,000	29,764	7,381,000	519,283	128,781,000
1916	564,338	151,243,000	104,005	27,873,000	28,776	7,712,000	697,119	186,828,000
1917	584,597	119,258,000	84,976	17,335,000	16,835	3,434,000	686,408	140,027,000
1918	492,405	89,618,000	25,522	4,645,000	9,918	1,805,000	527,845	96,068,000

[a] Value based on average St. Louis quotations prior to 1915; for 1915 and later years, on the average selling price for all grades.

[b] Annual average.



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